RESTRY

Crop Protection

WORLD CROPS

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Photo by courtesy of Fisons

Hiller spraying Rogor 40 on field beans, Essex 1959. Black fly control

Peaches from trees sun-kissed in another continent. Grapes from vineyards half a world away. Oranges new taken from crates labelled in a land where December is summertime. Fruit from the four corners of the world . . . a display once impossible, taken for granted today, part of everyday life. Yet, a triumph over odds.

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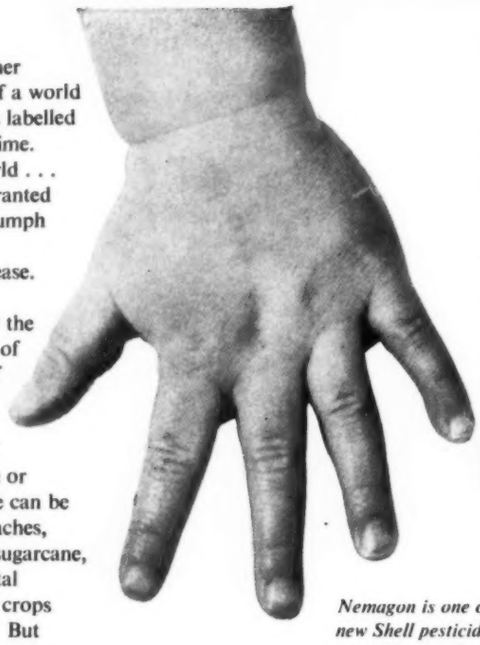

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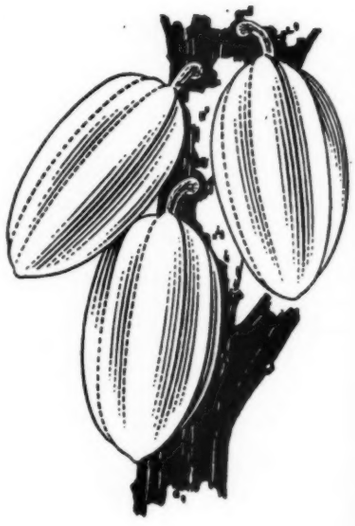

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Editorial Comment

Aerial Farming

THIS ISSUE of WORLD CROPS deals mostly with the subject of crop protection in general and the use of agricultural aircraft in particular. The extent to which aircraft are used will depend primarily on the seriousness of the need, the prosperity of the industry or of the nation. More and more farmers are coming to realise that their use in agriculture can offer positive savings in time, cost and labour; also no harm is done either to the soil or the crop.

There is a growing demand for a fuller understanding of the possibilities and the limitations of this new branch of mechanised farming, and agricultural aviation in all its aspects was the subject of the conference recently held in England under the auspices of the European Agricultural Aviation Centre at The Hague. The conference lasted a full week and concluded with a demonstration of spraying, dusting and top-dressing using fixed-wing aeroplanes and helicopters, and an exhibition of agricultural chemicals and supplies used in this industry, which was organised by the National Association of Agricultural Contractors.

Aircraft are now being specially designed or adapted for this kind of work and aerial contractors are prepared to fly to the ends of the earth to serve the agricultural industries of the world.

Helicopter v. Plane

ACCORDING TO G. H. Brenchley in an article, ' Spraying and Dusting Against Potato Blight ', in *Agriculture*, the main advantages of the system of concentrate spraying by aircraft are the avoidance of any mechanical damage, the speed at which the spraying can be carried out, and the fact that it can often be done when soil conditions are such that ground machines cannot be used. If it is carefully carried out, spraying from the air seems about as effective as ground spraying, but it is more likely that some part of the field will be missed from the air than from the ground. Even with markers the swaths may not overlap as they should, while obstructions such as power lines may result in a strip being left unsprayed. Irregularly-shaped fields and those bordered by trees may also lead to unsprayed or inadequately sprayed corners and patches. Difficulties of this sort are more easily overcome by the helicopter, with its lower spraying speed, than by fixed-wing aircraft.

In an open field, with no obstacles, there seems to be no difference in efficiency between the plane and helicopter; both can apply 3 gal. per acre and produce a reasonably uniform spray deposit. The two types of aircraft have about equal merits as far as speed of work is concerned. The fixed-wing aircraft sprays faster, but takes longer to turn round at the end of each run; therefore the helicopter will usually be quicker over the smaller fields, but over larger areas requiring few turns the fixed-wing plane will have the advantage. The helicopter also gains because it does not need a prepared landing strip, but, on the other hand, it is handicapped by squally and windy conditions.

Free with this Issue

THE HELICOPTER is obviously the ideal machine for treating small acreages, particularly where there are obstacles and hazards, such as trees, cliffs, pylons and power lines. It can place the chemical more exactly on the target than a fixed-wing aircraft, and there is less likelihood of material falling on adjacent crops. It can land on or quite near the scene of operations, so there is little wasted flying time.

Unfortunately, its first cost is high and its maintenance and running cost is higher than that of the fixed-wing, single-engine aeroplane. These major objections could be met by the introduction of a simple system of remote control, for if the pilot is eliminated the payload of the machine could be increased or the size of the machine could be reduced.

The idea is that the machine should be specially designed to be controlled from the roof of the mobile tank wagon, which serves as its operational base. For simplicity, once the machine has started, its vertical movement alone would be under remote control and its horizontal movement would be controlled by a guide line. This system would not only do away with the ground marker, but would also obviate the hazards normally associated with this type of flying.

Experiments with remote-controlled tractors in the U.K. have already been described (*vide* WORLD CROPS, 1959, **11**, 84), and in Russia automatic control is now being incorporated in 100 tractors to provide either circular ploughing along a spiral path or straight ploughing along a fixed line.* We now offer our million-dollar suggestion, *viz.* the remote-controlled helicopter, free with this issue.

Throwing Sputniks About

PUTTING FIRST things first is something which the world is not doing. Far too much attention is being given to the more sensational achievements of Russia and America in the field of astronautics and far too little to the more mundane business of preventing war by providing enough food for the world's teeming millions.

Speaking at the annual gathering of the Agricultural Engineers of Britain, Mr. L. C. Pearch, President

* Vide Lending Library Unit, D.S.I.R. R.24.1. July 1959

of their Association, said: 'Great Britain may not be throwing Sputniks about, but she is, undoubtedly, the world's leader in what many consider to be a much more worthwhile occupation – putting food in the mouths of the increasing millions of the world's populations and taking the fear of starvation away from them'.

There is much talk today of progressive disarmament as a means of establishing world peace, but peace will be impossible unless the world's food supplies can be assured or the increase in populations can be controlled, or both.

Dusting Reduces Crop Diseases

MANY DISEASES of crops are caused by bacteria and fungi carried in or on the seed, Mr. J. A. Crowe, an Australian crop seed expert, said recently. This source of possible trouble can usually be eliminated by dusting seed with a fungicidal dust before planting, or steeping it in a fungicidal solution.

One or other of these methods can be used according to the nature of the disease to be combated. The dust treatment has the additional advantage of providing a measure of protection against soil parasites because particles of the dust are carried into the soil in the seed coat.

Dusted seed, if planted under favourable conditions, will not rot before germinating and tends to reduce or eliminate damping-off losses.

Mr. Crowe has said that seed treatment alone will not always ensure absence of disease. Nevertheless, it is a worthwhile precaution, particularly as it is such a simple operation.

Parasitic fungi and bacteria harmful to crops are often to be found elsewhere than in seed. They might occur in a seedbed or field soil, in crops growing adjacent to the area, or on nearby weeds, botanically related to the crop being grown. Thus, crop rotation, weed control, seedbed and field sanitation, and sometimes spraying, might also need consideration, according to the *Australian Agricultural Newsletter*.

Secret History

DURING THE war there was a very severe outbreak of Colorado beetle, *Leptinotarsa decemlineata*, in Britain. The first reported outbreak was at Launceston, and from there the pest spread from potato patch to potato patch to Devon and Dorset and as far east as Worthing – in all a total of 14 serious infestations. This pest completely destroyed unsprayed plants and it was then assumed that this was one of Hitler's secret weapons designed to bring about a state of famine in Britain.

After the war it was discovered that this was not true and then it was remembered that the Eastern Counties of England had been unaffected. It was finally concluded that, as there had been no imports of potatoes from the Continent, the introduction of the pest must have been caused through the evacuation of refugees from Normandy, who inadvertently brought with them the larvae, or the beetle itself, in their clothing or belongings.

This notorious insect pest was originally introduced to Europe from America and it spread quickly over France, Belgium and Germany. Except for this invasion during the war, the Colorado beetle has been kept out of Britain.

The pest can assume very serious proportions and, according to a report, one break-out in the South of France was so severe that trains were held up owing to the beetles on the permanent way.

It is a reassuring thought that should it again appear in Great Britain it is now relatively easy to control by including an insecticide, such as DDT or lindane, with the copper fungicide when treating the crop for potato blight.

Rhinoceros Beetle

THE STANDARD methods of control of this pest are the collection of grubs from attacked palms by spearing and the destruction of their breeding grounds, principally the decaying trunks of fallen palms and the soft tips of standing palms which died as a result of 'tapering disease' (*vide* WORLD CROPS, 1959, **11**, 60). It is only fair to state that these control measures are more frequently neglected than observed and we have frequently speculated why the beetles never became so numerous as to seriously reduce the productivity of the industry in view of the pest's high reproduction rate.

Dr. P. Surany, pathologist of the South Pacific Commission, has for the last four years been studying the diseases of this beetle at his research centre, near Nairobi in Kenya, aided by a grant from the Rockefeller Foundation. He has discovered that two diseases are responsible for keeping the beetle population at a low level in S.E. Asia and East Africa.

He considers, however, more research is necessary before the direct control of *Oryctes rhinoceros* through infectious diseases will be possible. He is now going to survey the diseases of the beetle populations in certain infested Pacific islands, notably Fiji and Western Samoa. An interim report on this work is to be published by the Commission early in the new year under the title 'Diseases and Biological Control of Rhinoceros Beetles'.

War on Rabbits

A NEW RABBIT poison, sodium fluorocetate (Compound 1080), originally developed as a rat poison in the U.S.A., will, in the opinion of the C.S.I.R.O. of Australia, probably become the foremost rabbit poison there

because of its effectiveness and low cost relative to other means of destruction.

As the result of a series of laboratory tests of representative poisons, based on their toxicity and acceptability to rabbits, Miss M. Lazarus, of their Wildlife Survey Section, found that Compound 1080 was the most toxic to rabbits and also the most acceptable, for they would consume 10 to 20 times the minimum lethal dose without serious diminution of appetite.

The two main disadvantages of this poison are that it is toxic to certain domestic animals, particularly sheep and dogs, and the bait retains its toxicity for long periods in the field, even when subjected to severe weathering conditions. Although not selective in action, it can be safely used provided that obvious precautions are taken, such as removal of sheep from the area and muzzling of dogs so that they cannot eat the carcasses of poisoned rabbits. Losses of native fauna may also result, but these have not proved serious in practice.

Large-scale and very successful trials of the poison have been carried out in Tasmania, Western Australia and Victoria, kills of 70 to 95% being obtained when conditions are right. If careful attention is given to furrow placement and free feeding, excellent kills are achieved during the breeding season – the most difficult time for poisoning rabbits. The secret of success is the exact siting of poison furrows in relation to feeding habits, so that the rabbits are diverted to the new source of food.

The development of these campaigns in Australia will be followed with interest in a number of countries. The success of myxomatosis was outstanding, but carried with it certain objections; not least, in our opinion, was the appalling effect on the animal as the disease progressed. Rabbits are a pest and must be destroyed. From our personal observation we do not believe that myxomatosis was the most humane method of destruction and we shall welcome the new rabbit poison if it achieves its object without inflicting pain on the animal.

A Royal Welcome

LAST YEAR 1,740 visitors from 60 countries signed the visitors book in the Overseas Pavilion of the Royal Show. This year there were 2,085 visitors from 70 countries, including His Excellency Y. Malik from the U.S.S.R., M. Maurice Commerts, the Belgian Ambassador, M. Colbert Bonhomme from Haiti and the Agricultural Attachés for Hungary, Spain, The Netherlands and the U.S.A. Australia had the largest contingent (292), New Zealand second (228), U.S.A. was third (176), Kenya fourth (152), with France fifth and Germany sixth.

Stewards speaking a variety of languages were available to guide and assist the visitors and make the necessary introductions. There was also a technical bureau for answering enquiries and facilities for rest and refreshment.

Rice Oil

RICE BRAN contains an oil and a wax which could become useful by-products where milled rice is produced on a considerable scale. Furthermore, the value of the bran as a feed for livestock is said to be enhanced by the removal of this oil. It is tasteless and odourless and similar to cotton seed and groundnut oils. It can be refined, it keeps well and can be used as a cooking oil.

In the U.S.A. a rice oil industry has developed, largely as a result of investigations carried out by the Agricultural Research Service of U.S.D.A. at New Orleans. The industry there is now producing over 5,000 tons of refined oil a year, worth about £500,000 and it is estimated that this could be increased five times if all the rice bran produced in the U.S.A. were processed.

The major rice-producing countries of the world – China and India – together represent over half the total area under this crop and rice oil could therefore be produced in considerable quantities and not only provide a useful food oil, but also create another source of income for the rice millers and so indirectly benefit rice growers.

Spotlight on India

THE NEWS that New Delhi is to set the stage for a World Agricultural Fair in December has not aroused a great deal of enthusiasm among British manufacturers of agricultural machinery, although both the Russians and the Americans are taking the opportunity to stage propagandistic exhibits designed to show the power of their respective agricultural machinery industries.

The Triumph of Modern Science

IN SUGAR production techniques and per-acre production Hawaii leads the world, and the same can be said for its pineapple industry. The latter is, indeed, a triumph of mechanised agriculture and a leading example of the use of chemicals in agriculture. Many years ago, using machines mostly invented or developed in the islands, pineapple growers were fumigating the soil, laying paper mulches to control weeds and accelerate plant growth, applying fertilisers by exact placement machines, spraying trace elements and applying insect sprays by means of 30-ft. boom sprayers over the perfectly contoured and geometrically designed beds, which were specially tailored to permit mechanical harvesting into lorries directed by wireless from a central command post.

The pineapple industry of Hawaii is not only the most highly mechanised agricultural industry in the world, but is also an interesting example of the triumph

of modern science over natural processes in that the same land has been repeatedly and successfully planted with the same crop for well over 50 years. Several times has the industry been threatened with extinction and each time the scientist has come to the rescue with his fungicides, insecticides, herbicides and chemical fertilisers, including the minor and trace elements, which have been found to be just as important as the major elements.

A New Service for Agriculture

COMPETITION AMONG employers for science graduates is as strong as ever, as is proved by the large sum now being spent on advertisements in newspapers and technical journals. To the cost of advertising must be added the expense of management consultants and others whose services are being used to help satisfy the often desperate need for scientific and technological recruits of graduate status.

A far less expensive way of solving this problem has been put forward by Mr. Leonard Hill, Chairman of *The Leonard Hill Technical Group* of periodicals, reference books and textbooks. His long experience as a technical and industrial publisher has given Mr. Hill a deep insight into the problem of staff recruitment and the new system he proposes is the fruit of a long study of the situation.

Most students seek temporary employment during the university vacations. Mr. Hill proposes that science students should work temporarily for firms of the type which would offer them jobs after they have graduated. This would enable students to become acquainted with the industries in which they propose to make careers and, conversely, would enable employers to assess the potentialities of young men and women who they may wish to employ after they have obtained their degrees.

'We find overhead spraying much the most effective way of clearing grazing land'

ISIS Appointments Register

HOW WILL it work? Mr. Hill has established the *ISIS Appointments Register* at the headquarters of *The Leonard Hill Group* in London. Science students can apply for registration and individual employers and firms requiring temporary staff will be invited to submit details of the jobs they can offer. In this way *ISIS* will bring together employers and employees in an economical and efficient manner. A further saving to employers will be the elimination of extra work caused by the employment of temporary workers. This will be done by employers paying *ISIS*, who will in turn pay the students and deal with all income tax and insurance details. In effect, the students will be employed by *ISIS*.

During the period of temporary employment firms will be expected to give students work commensurate with their abilities, since the way in which the students are treated will naturally influence their choice of future career and employer. Most students will cheerfully undertake most jobs, provided they are intelligently and sympathetically handled and are given proper opportunities to assess the career possibilities offered.

The *ISIS Appointments Register* will bring together employers and future employees for a valuable preliminary period. The use that is made of this period depends upon the good sense of each side. Employers who require further details of this service to industry should communicate immediately with *ISIS Appointments Register*, 7-9 Eden Street, London, N.W.1 (Telephone Euston 5911). Registration of employers' requirements for the Christmas vacation has begun.

Poetic Justice

OUR READERS will be glad to learn that Dr. E. Holmes, President of the Fourth British Weed Control Conference, has now nearly recovered from his recent serious illness. In a humorous progress report covering the period May to August he states that he had to take nine pills of five different varieties a day, and the build-up of chemical residues became so oppressive that ultimately he was allowed Nature's own remedy – a large cognac.

Believers in the muck-and-mystery system of agriculture will no doubt consider it nothing but poetic justice that a leading weed killer should have to take his own medicine.

Technical Aspects of Agricultural Aviation

C. J. EDWARDS

IN the U.K., agricultural aircraft are used chiefly for applying spray to crops, but recently fertiliser application is increasing in importance. Two main types of aircraft are used – the fixed-wing and the helicopter.

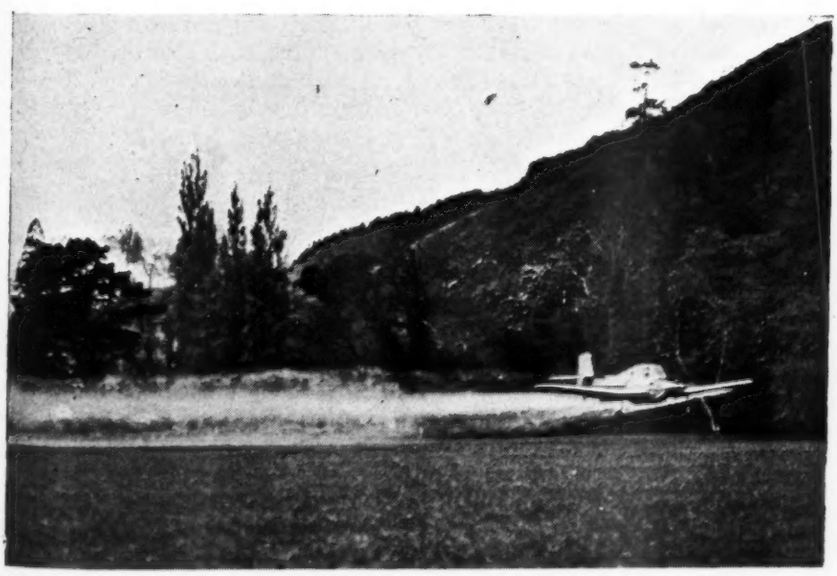
The helicopter is expensive to buy and to maintain, but it can land on or near the field being sprayed, thus eliminating loss of time in ferrying from supply unit to field. It can quickly change its speed or height, and its excellent manoeuvrability means that spraying can be carried out close to obstacles, such as trees, pylons or poles. As a helicopter generally sprays at a slower speed than a fixed-wing plane, the pilot can more accurately ' place ' the spray on the field being treated and there is less likelihood of missed areas or of spray falling on adjacent fields.

A Hiller helicopter spraying a field of young sugar-beet in Norfolk. The safe systemic insecticide, Rogor 40, is being used to control aphids and virus yellows

On the other hand, a fixed-wing aircraft is relatively cheap to buy and maintain. A landing strip is essential and, although a moderately level grass field will suffice, these are often scarce, especially in intensive arable areas. The aircraft may then have to use a site up to several miles from the actual field and the loss of time in ferrying results in low output. Generally, they fly at 65 m.p.h. or more and cannot as accurately ' place ' spray as a helicopter travelling at 25–45 m.p.h. This type usually has a higher payload than a helicopter and can thus spray a larger area with each load.

For fixed-wing aircraft, it is desirable to have fields of, say, 50 acres or more, while for helicopters 20 acres is quite satisfactory. On average the output in acres per hour from a helicopter is higher than from a fixed-wing plane for fields of under 90 acres approximately, and as most fields in the U.K. are under 90 acres, the helicopter is very popular in spite of its expense.

Until three or four years ago the only type of spray equipment on aircraft was the spraybar, where nozzles break up the liquid into spray. The pump was driven by a windmill in the case of fixed-wing planes or by the main engine in most helicopters. In recent years the rotary cage is being used as another method of producing a spray. By this method the liquid is fed into the centre of a gauze cage, which revolves very quickly, thus throwing out the liquid as a spray. The spray droplets are probably more uniform than from a spraybar and the size of droplets can be adjusted by altering the speed of rotation of the cage. Unfortunately, the rotary cage can only use emulsions or solutions,



The Agricola (Auster Aircraft Ltd.) seen in service in New Zealand, where it is used for fertilising hill land from the air

and thus may need special chemicals, whereas with spraybar gear the normal chemicals, including suspensions, can be used. The droplet size of the spray from a spraybar can be adjusted by changing nozzles or by orientating the nozzles forward or backwards, and, although this adjustment takes longer to do, this is more than offset by the versatility of the gear.

In the U.K. the volume of application varies from 1 to 5 gal. per acre, depending on the job. The swath width depends on the plane and also on the operation, *e.g.* a helicopter may be able to do 60-ft. swaths for fungicide on potatoes, but only 45 ft. for insecticides on some other crop. To ensure even spray distribution, it is desirable to have a good overlap between one swath and the next, and the best way of achieving this is to fly across wind rather than up and down wind.

Most aircraft tend to deposit more spray directly under the fuselage than elsewhere, thus causing under-dosing at the edge of the swath. This effect can be minimised by flying at the optimum height, *e.g.* with a Hiller helicopter the spraybar should be approximately 9 ft. above the crop, but for an Auster it should be 12–15 ft. in winds of up to 5 m.p.h. For stronger winds the height should be lowered. Some operations should only be carried out in low winds, *e.g.* applying insecticides for aphis, while other operations can be undertaken in moderate winds, *e.g.* fungicide on potatoes.

The most important auxiliary equipment for aircraft spraying is a good supply unit. Preferably this should have separate tanks for water and spray mixture as well as being able to carry chemical and aviation fuel. It should have a trigger valve at the end of a hose reel to enable quick filling of the aircraft without loss of chemical.

A typical spraying team might consist of one pilot, one engineer, four markers, one driver for the supply unit and one supervisor. In cases where the fields are several miles apart it is best to have two supply units per aircraft so that the plane is never short of supplies.

For fertiliser distribution the fixed-wing plane is more suitable than the helicopter because of its higher payloads. Sprays are normally applied at an average of 30 lb./acre compared with fertilisers, where the required rate is generally 1–4 cwt./acre. As the small fixed-wing planes can only lift about 700 lb., they usually need filling up very frequently and it is important that this operation should take the minimum amount of time. Some operators do this by fitting a hopper of the correct size on the 'foreloader' of a tractor, which then manoeuvres the 'foreloader' just above the plane's hopper before releasing the load.

Abstracted with permission from *The Farm Contractor*, September 1959.

Coming Events

Grassland. – The 8th International Grassland Congress will be held at Reading, England, from 11–21 July, 1960. Enquiries and requests for application forms should be addressed to the Secretary, 8th International Grassland Congress, Reading, Berks.

Corrosion. – The 1960 Exhibition will take place at Olympia, London, from Tuesday, 29 November, to Friday, 2 December. A complete range of anti-corrosion materials, methods and equipment will once again help industry to fight the menace that costs Britain £600 million a year. Bookings are now being accepted and full information is available from the Organiser, *Corrosion Technology*, Leonard Hill House, Eden Street, London, N.W.1.

Agricultural Exhibitions

England. – The Smithfield Show and Agricultural Machinery Exhibition at Earls Court will be held from 7–11 December this year. Enquiries should be addressed to the Smithfield Show Joint Committee, Forbes House, Halkin Street, London, S.W.1.

India. – New Delhi will be the centre for a World Agricultural Fair to be held from 11 December–14 February, 1960. Further information from World Agricultural Fair, Exhibition Grounds, Mathura Road, New Delhi.

Canada. – The Canada Farm and Industrial Equipment Trade Show will be held at Exhibition Park, Toronto, from 27–30 January, 1960. Further particulars from Canada Farm and Industrial Equipment Show Ltd., 4969 Yonge Street, Willowdale, Canada.

Belgium. – The 40th International Agricultural Machinery and Equipment Exhibition will be held from 14–21 February, 1960. Details may be obtained from Societe de Mecanique et d'Industrie Agricole, 29 rue de Spa, Brussels 4.

Persian Gulf. – Agricultural Show and Trade Fair will take place from 31 March–7 April, 1960. Information may be obtained from Department of Public Relations and Broadcasting, Manama, Bahrain, Persian Gulf.

World Ploughing Contest

The Seventh World Ploughing Contest, in which representatives from 16 nations participated, was held at Armoy in Northern Ireland and was won by W. L. McMillan, of Co. Down. The champion, and also the two Canadians who came second and third, used a combination of a Ransome plough and a Fordson Power Major tractor fitted with Goodyear tyres

Refuelling on site during a field operation in Berkshire. A Hiller helicopter receiving supplies at its operational base

Fifty Years of Aerial Farming

Crop Protection from the Air

The first International Aviation Conference to be held in Europe was organised at the request of the European Agricultural Aviation Centre, centred at The Hague, and took place at the College of Aeronautics at Cranfield, Bedfordshire, in England. The Conference was attended by delegates from over 20 countries.*

THE Conference was called primarily to consider the technical problems of the rapidly expanding field of agricultural aviation, and in his inaugural paper Sir Miles Thomas, D.F.C., M.I.MECH.E., M.S.A.E., appropriately reviewed the development of aerial farming over the past 50 years. Almost half a century ago – only eight years after the Wright brothers had made their first successful flight in 1908, a German forest warden applied for a patent covering the use of aircraft to destroy woodland pests by dropping chemicals on their habitat.

Little came of this pioneering concept, he said, and it needed another seven years before experiments in agricultural aviation were begun in the U.S.A. These early operators were faced with the necessity of using obsolescent military aeroplanes, pumps designed for industrial uses, nozzles used in fire-fighting, and chemicals intended to be scattered from horse-drawn carts.

By 1921 a specially equipped aircraft had proved its value in destroying caterpillars in the U.S.A., and thereafter aerial spraying and dusting began a slow but steady expansion. Aerial attacks were launched in North America and Europe against the boll weevil, canker worm, gipsy and nun moths, pine looper and other sylvan and agrarian pests.

Not all these operations were successful. Frequently the poison dusts were carried off target by air currents and instead of clinging to the foliage the particles were often blown off by strong winds, or washed away by rain. Furthermore, the large quantities of insecticide used during these early operations made aerial farming a very expensive business.

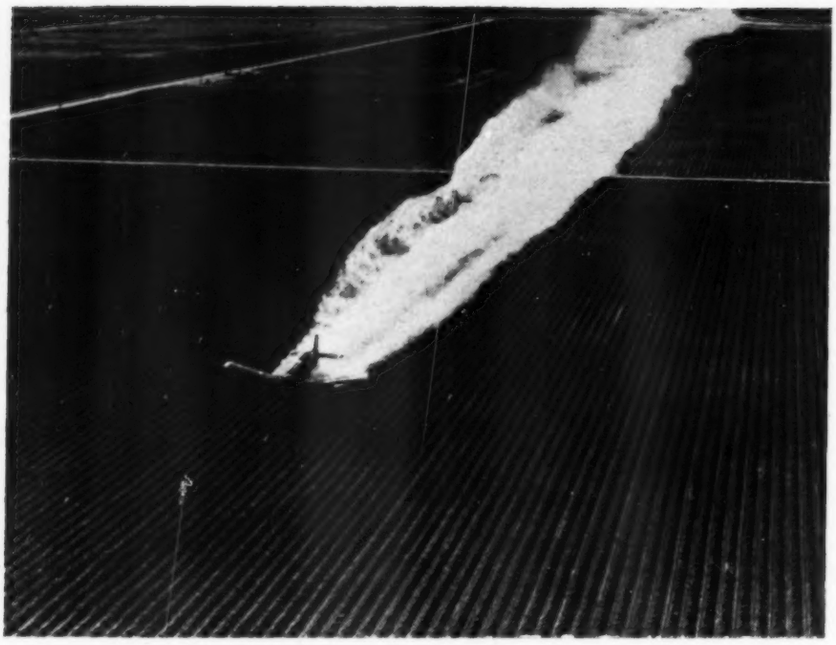
Few understood the principles of air flow around an airborne object, and they knew nothing about the paths followed by dust particles or liquid droplets released from the air. Improvements came fast when engineers and scientists began to apply themselves to these problems, and among them were new, more efficient dispersal equipment and better spreading devices. After 1940 the science of aerial farming entered a period of steady growth.

In U.S.A.

By 1951, U.S. pilots were treating about 39 million acres a year. Seven years later the figure had risen to approximately 60 million acres – an area almost equal to the whole of Great Britain. It is estimated that about 4,000 pilots dropped almost 700 million lb. of dry material and sprayed nearly 100 million gal. of liquids on these 60 million acres. Their total flying time was about 850,000 hours. In other words, their average application rate was around 70 acres per flying hour.

Most of this acreage – almost 80% of it – was dusted or sprayed to rid it of insects and plant diseases. The area remaining was ' sky-farmed ' for a variety of purposes, including weed

* Organised by the Ministry of Agriculture, the Ministry of Transport and Civil Aviation and the National Association of Agricultural Contractors and a representative committee of scientific, trade and other associations.



Large-scale operations in the U.S.A. A Transland Ag-2 agricultural aeroplane laying a 42-ft. swath of dust over cotton for mite and lygus control

and brush control, fertilisation, defoliation and seeding.

In Britain

British operators are in a far less fortunate position than their American counterparts, for even today agricultural aviation is still not generally accepted in this country as a routine aid for the farmer.

There are about 13 operators of agricultural aircraft in Britain and, of the 40–50 aircraft in use, most of them still are either of war-time or pre-war vintage. These are independent and private ventures, for, although the attitude of the Ministries and other official bodies is favourable, they are not able to provide any financial aid.

There is one most notable development in agricultural aviation which Britain has pioneered. It is the use of the helicopter for crop spraying and other agricultural duties. The main drawback is the initial cost, which is many times higher than a single-engined fixed-wing aircraft, but the versatility and manoeuvrability of the helicopter also give it many advantages. In addition, the helicopter can treat almost twice the acreage per hour of the fixed-wing machine.

The first experiments in crop spraying by helicopter in Britain took place over 14 years ago and proved, contrary to expectation, that some spraying operations could be successfully completed using as little as 5 gal. of spray per acre.

Helicopters also played an important part in last year's combined operation against potato blight. As a result some 56,000 of the threatened acres of potatoes yielded an average of over 10 tons to the acre, whereas without treatment the blight would have reduced the yield to about 2 tons per acre. Although some had to be treated five times, this was still cheaper for the farmers than losing their crops.

In New Zealand

The importance which New Zealand places on agricultural flying was emphasised in a recent Government report, which stated that in the year ended March 1957 New Zealand agricultural aircraft dropped 428,000 tons of fertiliser – about half the country's production. The operators were subsidised by the Government for a vast scheme of applying top-dressing. The scheme caught the imagination of the farmers and now – although the top-dressing application is finished and the Government subsidy is curtailed – the industry is established on a firm commercial basis.

Increased farm productivity as a result of these schemes has, in turn, built demands for the subsidiary use of aircraft in such tasks as seed sowing, rabbit poisoning and supply dropping, including the positioning of fencing material over difficult terrain. The rabbit menace, which previously cost New Zealand millions of pounds a year in depleted pastures, has been largely eradicated through the use of aircraft.

In other countries

Many countries with their own local problems and specialised experiments have contributed much to the story of aerial farming. The aeroplane is no new-fangled contraption to the farmers in such widely scattered countries as Sweden, Guatemala, Mexico, Japan and the Netherlands.

Yugoslavia, Iran, Brazil, Colombia – countries many of us still associate with mules, primitive hand ploughs and peasant labour, all use aircraft in farming. Yugoslavia in 1957 cleared 150,000 acres of woodland of the gipsy moth and saved 8,000 acres of sugar-beet from disease by aerial spraying.

Last year a plague of locusts was eating its way across the cultivated lands of Iran. The Government realised that only by aerial spraying could the march be halted and put out tenders to aircraft operators. The Russians flew in 12 crop-spraying aircraft and wiped out the locusts.

The Governments of Brazil and Colombia have used them in extensive sowing projects. Five years ago in Colombia, for example, rice was grown on a comparatively small scale. Aircraft sprayed large areas to clear scrub and brush. Rice was sown from the air; later the growing crop was again sprayed to kill the weeds and an outstanding crop was produced.

Recent trends

In the U.S.A. there is a trend towards more aerial treatment of land planted with rice and cotton. In California, for example, 95% of all the rice grown is seeded, weeded and fertilised from the air, and an estimated 60% of all U.S. cotton is now treated aerially.

New fertilisers, insecticides and other specialised formulations are being developed to meet the need of the flying farmer. The new high-analysis ammonium phosphate fertilisers are showing great promise as fire barriers. Sprayed in aqueous solutions from low-flying aircraft they are proving most effective in halting the spread of forest, brush and grass fires. Due to this development of new spraying techniques and equipment,

the cost of aerial application is comparable with that of ground spraying machines.

What of the future?

There is need for additional technological progress. For its biological warfare, agricultural aviation requires the development of additional new chemicals designed for low-volume, high-speed application; safer aircraft with better take-off and landing capabilities, and bigger payloads; dispersal systems to allow wider swaths; and application techniques which do a better job of getting the chemicals where they are needed. Obviously research and development efforts must continue if agricultural aviation is to follow its upward course.

Modern agriculture has increasingly become a battle of productivity – of how much men may win from their environment when their own physical and mental abilities are reinforced by applied science. Agricultural aviation, because it is clearly a key to farm productivity, surely will make important gains in tomorrow's world. Nevertheless, this is not an eventuality that will just happen; there will still be obstacles to meet and surmount, he concluded.

The Proceedings of the Conference are to be published in full, but some time must elapse before these will be available. Accordingly we are publishing a brief account of a number of selected papers:

Materials for Aerial Application and their Properties *by J. K. Eaton (Woodstock Agricultural Research Centre, Kent)*

This paper dealt with the techniques for applying concentrated sprays and fertilisers, with particular reference to the factors which influence the choice between ground and aerial applicators. The various types of formulations – dusts and granulations; solutions, emulsions and suspensions – which can be used for aerial application were reviewed and their advantages and disadvantages discussed. A survey was given in general terms of the success achieved so far by the aerial application of pesticides and fertilisers in various parts of the world. Considerable advances have already been made, particularly in the sphere of nozzle design, and now special formulations with appropriate physical properties are required for the latest application techniques.

Photo: Yorkshire Post

A top-dressing operation on pastures in rough country in Yorkshire. A Prospector (Lancashire Aircraft Co. Ltd.) agricultural aeroplane seen in action. Note the ground marker

The Problem of Distribution, the Physics of Falling Droplets and Particles, and the Drift Hazard *by D. Yeo (Colonial Pesticides Research Unit, Tanganyika)*

When applying any agricultural chemical the aim is to put it in the right place at the right time, and in the right form. One must avoid, as much as possible, any undesirable side-effects, such as disastrous upsets in the natural mechanisms of pest control or the drift down wind of dangerous concentrations of toxic chemicals, such as weedkillers.

This paper detailed the four factors which determine the distribution of the droplets or particles released from an aircraft and the four ways in which they are collected on the target.

The author concluded that for high rates of deposition the droplets or particles must be large and volume median diameters must be greater than 200μ if effective deposition is to be 80% or more within short distances down wind. Somewhat smaller sizes, resulting in greater numbers for a given rate of application, give more uniform and better distributions of chemical, but their use would not be recommended if the chemical might give rise to a toxic hazard at distances down wind. Aerosols and dusts, with volume median diameters of 10–40μ, give relatively low recoveries within short distances down wind, but such small sizes are required if, for example, insects within a vegetation canopy are to be dosed directly; such small sizes do give rise, however, to the greatest drift hazards.

Meteorological conditions, notably wind speed and direction, modify dosage distributions near a low-flying aircraft, while wind speed and atmospheric turbulence dominate the drift hazard for a given method of application.

The aircraft wake modifies dosage distributions and advantage can be taken of it to increase swath widths for low-flying aircraft. Flying very low improves the dosages obtained upon a vegetation canopy, but treatment of under surfaces is rarely satisfactory with aircraft.

Distribution Equipment *by R. F. Hill (Colonial Pesticides Research Unit)*

This paper listed the problems which arise in designing distribution equipment for the aerial dissemination of insecticides. At one time surplus wartime aircraft were used. Comparatively few of these machines now remain and, due to the cost of over-

Two helicopters fitted with spray booms seen in action. Left: *the Kolibrie-H3 (European Helicopters Ltd.).* Right: *the Hiller 12C (Fison-Airwork Ltd.) spraying an orchard of Cox's Orange Pippins*

hauls and renewals at present-day prices, they are no longer cheap. There are a few aircraft available designed specifically for agricultural work and some to be easily adaptable for many different roles, including aerial spraying.

The designer has a wide choice of materials from which to choose, including some in the rapidly expanding field of plastics. In addition, a considerable amount of research work has been carried out on the fundamental problems of component design, such as jets and atomisers, as well as the resistance of the materials in use to the corrosive effects of the chemicals used. The requirements for such components were considered in detail.

International Airworthiness Requirements for Agricultural Aircraft *by H. G. Winton (Air Registration Board)*

This paper surveyed the airworthiness requirements applicable to agricultural aircraft in New Zealand, U.S.A., Australia and U.K. under the following heads: structural strength, performance and flight characteristics, design of tanks and distributing apparatus, corrosive effects of agricultural chemicals, provision for pilot safety in crash landings, and fire risks.

Corrosion by Agricultural Chemicals in Airframes and Equipment *by F. C. Porter (Aluminium Development Association)*

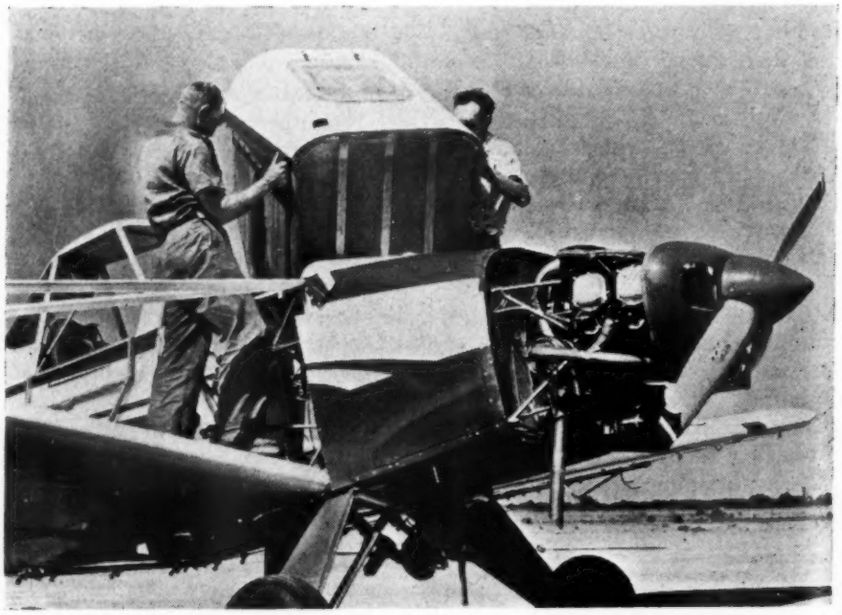
General principles of corrosion were discussed with particular reference to deterioration by pesticides and fertilisers of the structural materials used in aircraft and crop-spraying equipment. Published data shows stainless steel to have high corrosion resistance, with monel metal generally good. Aluminium alloys are most widely used, both in airframes and equipment, and these, with regular cleaning, give satisfactory resistance to most chemicals. Brass and copper seldom corrode seriously, but may give rise to serious bi-metallic effects. Magnesium-based and mild-steel aircraft materials are normally painted and cause few problems if the paint is maintained. Brief reference was made to coating systems and their resistance to the agricultural chemicals. Fibreglass-reinforced polyester plastic has shown a promising resistance to corrosion. Airborne deposits may promote corrosion by poultice effects.

Economic Factors Affecting Aircraft Operations *by N. D. Norman (Crop Culture (Aerial) Ltd.)*

The tremendous economic advantages conferred by agricultural aviation by large-scale operations in certain overseas countries tend to obscure the fact that the duration of the seasons, the crop distribution and other limiting factors bear heavily on the economics of similar operations in Europe.

The approximate operating costs of a light agricultural aircraft were given; it was considered to be unlikely that within the foreseeable future new equipment for aerial spraying and top-dressing will be produced which will enable really substantial reductions in the cost of these operations.

It is more likely that operating



A lightweight 150-gal. polyester plastic hopper reinforced with fibreglass being fitted to the fuselage of the Piper Pawnee (Farmair Ltd.)

economies will be achieved by increasing the work output per productive hour with existing equipment. This may be achieved by applying a price differential to increase the charge for treating small uneconomic areas and by ensuring that operations are undertaken only in areas where they can be profitable to both the farmer and the operator.

The alternative approach to improving the economics of agricultural aviation lies in the direction of extending the season. The most immediate prospect under this heading would appear to be heavy fertilising and liming of marginal lands supported by pasture improvement, by bracken killing and selective grass killing and grass seeding. Another prospect is weed control by aerial application on cereal crops and pastures. This work has been restricted by the drift hazard, but new materials and equipment may change the picture.

Safety Aspects of Aerial Spraying *by E. F. Edson (Chesterford Park Research Station)*

Comparisons were made between the known problems of ground spraying and those specific to aerial operations. Much information is available on the former which, if adopted, permits the vast majority of ground operations to be carried out in safety. A similar standard of care is required in aircraft operations with the same chemicals, with extra precautions to avoid the new risks specific to air spraying. Codes of practice or recommendations for such safety measures can be devised, but they are bound to have the effect of slowing up or complicating aircraft spraying, when using toxic chemicals.

Flying Technique for Fixed-Wing Aeroplanes *by L. R. Lucassen (National Aeronautical Research Institute, Holland)*

Agricultural flying is generally executed at very low altitude; the pilot has little time for his instruments and must rely mainly on his flying 'feel'. The paper discussed situations that might arise in low-level flight and told the pilot how to foresee, recognise and avoid dangerous manoeuvres. Loading conditions are highly variable and require frequent retrimming in order to keep control forces approximately constant. The technique for take-off and landing on short fields and the influence of ambient temperature and field elevation on performance were discussed.

The main part of the paper was devoted to the influence of wind, giving landing technique in cross-wind, possible erroneous action in turning flight from cross-wind and the effect of wind gradient on aeroplane performance and amount of aileron required in a turn.

Ground Organisation – The Pilot's View *by R. Bradbury (Fison-Airwork Ltd.)*

This paper outlined the problems and gave an account of essential requirements in headquarters and ground personnel, refilling and refuelling equipment, and in mapping, navigation and field marking. The hazards were considered together with the legal aspects of aerial spraying operations.

Ground Organisation – The Ground Operator's View *by M. Bradford (National Association of Corn and Agricultural Merchants)*

The essentials for effective operation are a properly briefed sales force made up of individuals who understand the potential and the limitations of agricultural operations; also a team of efficient pilots and a ground staff, including markers, who are understanding and co-operative. The problems which confront the agricultural merchant were discussed.

The D.H.C.2 Beaver (De Havilland Aircraft of Canada Ltd.) flying low over sugar-cane in India so as to produce maximum saturation

More Tractors Wanted

The Fifth National Convention of the Farmers' Forum of India has made unanimous appeal to the authorities to make more tractors available to the *ryots.** Resolutions urging liberalisation of tractor and spare parts imports and the removal of duties on powerine and diesel fuels were passed with enthusiastic acclamation by 4,000 delegates present.

The Massey-Ferguson organisation demonstrated a number of agricultural implements using a M-F 35 tractor. A cut-away model of the M-F hydraulic system, the 'heart' of every Ferguson system tractor, aroused a great deal of interest amongst farmers, who sought many technical details.

*Ryot: An Indian peasant or cultivating tenant.

Technical News

Articles in the November issues of some of the other journals of the Leonard Hill Technical Group include the following:

Chemical & Process Engineering. – 'Drying' by W. F. Calus, M.SC., D.L.C., A.M.I.CHEM.E.; 'Chinese Progress in Nuclear Science'.

Manufacturing Chemist. – 'Safety in the Chemical Industry' by S. Price; 'Detergents and Detergency' by L. Raphael.

Petroleum. – 'French Saharan Developments' by M. J. Bertin-Roulleau; 'Refinery Expansion in Europe' by T. H. H. Skeet, LL.B., M.P.

Specimen copies of the above journals are available on application to Leonard Hill House, Eden Street, London, N.W.1.

Plant Nematodes

J. G. R. STEVENS, B.SC.(AGRIC.)*

Nematode-infested tobacco plant, showing typical wilt

Nobody knows the value of crops lost all over the world to plant parasitic nematodes, or eelworms, year after year, but if a figure could be computed there is no doubt whatever that it would be astronomical.

ALTHOUGH the existence of plant parasitic nematodes as soil pests has been recognised for many years – in 1880, for example, efforts were being made in Germany to control eelworms in sugar-beet – it is only during, and more particularly since, World War II that any serious interest has been taken in their control except under very limited conditions. Now nematode damage is being increasingly acknowledged as a serious threat to agricultural production; indeed, it is becoming evident that many of the losses in crop yields which but a few years ago would have been attributed to drought or nutritional deficiencies are, in fact, the direct result of attack by nematodes.

Plant parasitic nematodes of one species or another occur in practically all soils in which crops are grown and there are believed to be very few crop plants which are not, or cannot under certain circumstances be, attacked by them to a greater or lesser degree.

In temperate climates

In temperate climates, as is well known, potatoes and sugar-beet are especially liable to attack (by *Heterodera rostochiensis* and *H. schachtii* respectively), often with very serious consequences. Tomatoes and other horticultural crops grown both under glass and out of doors may also suffer severely from nematode attack – usually by root-knot nematodes, *Meloidogyne* spp. As an example, a case has been recorded in Scotland where tomatoes grown under glass in a nematode - infested soil were not thriving. Once the nematodes were controlled by soil fumigation – with D-D[1] in this case – the plants doubled in height and yield was increased by more than 40%.

Further examples of the economic losses wrought by nematodes in temperate climates come from Holland. Two are provided by the famous bulb industry: in tulip fields, where there is a high nematode population, control of the pest, *Pratylenchus penetrans*, may result in yield increases of up to 100%. Where narcissi are heavily infested their value may be only about 4,000 guilders per ha., compared with up to 10,000 guilders where nematode infestation is light or non-existent.

Work in Holland has also shown the marked extent to which tree seedlings can suffer from nematode damage. Where tree cultivation is carried on for many years on the same soil, nematodes, chiefly *Pratylenchus penetrans*, cause poor, patchy growth of the crop, which is then said to be showing symptoms of ' soil exhaustion '; yields may be reduced by 10–20%.

Nematodes in the tropics

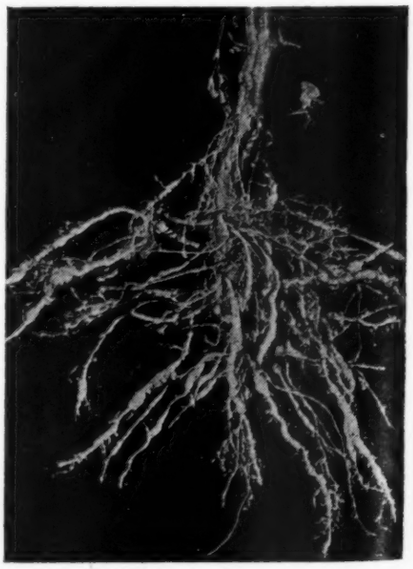
Although much of the research done so far on nematode problems has been in temperate zones, nematodes are probably an even more serious menace to crop production in tropical and sub-tropical areas. It would be inappropriate to list here all the tropical and semi-tropical crops which are now known to be subject to damage by nematodes, but among the most important are such perennial crops as pineapple, sugar-cane, tea, pepper, and many tree crops, including citrus, peach, banana and vines; tobacco and cotton, too, are very liable to attack by nematodes.

In one or two cases whole industries, based on one or another of these crops, have been in danger of extinction as a result of nematode infestations. In the Indonesian island of Banka the pepper industry has, in fact, been virtually destroyed by nematodes. In another country some years ago an important pineapple industry was saved by the timely development of an economic nematocide.

In Southern Rhodesia, tobacco is constantly under attack by root-knot nematode, *M. javanica*, and it has been stated that this pest, present on almost every farm, is possibly

* Shell International Chemical Co. Ltd.

[1]D-D is a Shell registered trade mark.



Roots of a tomato plant damaged by nematodes. The plants were grown at a farm near Viareggio, Italy

one of the more important single causes of crop loss. Where nematodes are controlled an additional 300 lb. of leaf may be harvested per acre – an increase approaching 50%.

Nematodes are an important limiting factor in the production of cotton in Mexico, where in the Mexicali region, of the 500,000 acres under this crop, 100,000 are known to be infested with nematodes. Experiments with soil fumigation, using 'Nemagon',[2] gave increases in yield of up to two and a half times that of the control.

Nematode control trials on tobacco in the Transvaal. Left: *control suffering from nematode infestation.* Right: *healthy tobacco treated with a Shell soil fumigant.* Right centre: *one row showing slight evidence of eelworm infestation (the guard row).*

More nematologists needed

These few examples serve to show how nematodes can be, and are, responsible for serious crop losses. Why, it is being asked, has so little research into the plant parasitic nematode problem been carried out outside the U.S.A. and Western Europe? And why, now that efficient and economic soil fumigants are available, are control measures still far from universal? The answer to both these questions lies to a great extent in the fact that nematodes, being extremely small organisms (their length is on average about 1 mm.), are not easily seen in the soil with the naked eye (their presence can usually only be detected by microscopic examination), and that the above-ground symptoms of attack (wilting and generally poor growth) are rarely sharply defined and may well be mistaken for symptoms of nutritional deficiency, drought etc.

Comparative development of cotton plants in Mexico. Right: *untreated controls severely infested.* Left: *treated with 4 gal. 'Nemagon' 25% v/v per acre*

Beyond the U.S.A. and Western Europe there are at present relatively few trained nematologists, and this fact, together with the difficulty of identifying nematode damage in the field, results in a general lack of awareness of the problem. There is, in fact, an urgent need for trained nematologists who can work alongside plant pathologists and entomologists in the field; and by the same token there is an equally urgent need for more up-to-date literature on nematology.

Books on nematology

Until the recent publication in the U.S.A. of a new textbook[3] on this subject almost all that has been learnt about plant nematodes and their damage during the last decade or so has been recorded solely in scientific journals, which are often available only in libraries, when the need is for literature to use in the field. The standard works on the subject until now have been *Plant Parasitic Nematodes*, by the late Dr. Thomas Goodey, first published in 1933, the same author's *Soil and Fresh Water Nematodes* (1951), and *A Manual of Agricultural Helminthology*, by the late I. N. Filipjev and J. H. Shuurmans Stekhoven (1940). But valuable though these works are as textbooks on the biology of nematodes, they do not contain up-to-date information on classification and control.

Now, however, a new era in nematology literature seems to be starting. Besides Dr. Christie's new book, there is news that Dr. J. B. Goodey, of Rothamsted, is working on a complete revision of his father's *Soil and Fresh Water Nematodes*, and that Dr. Gerald Thorne, of Wisconsin University, is also engaged on a book on nematology.

One looks forward to the expected books reaching as high a standard of usefulness – not necessarily in the same way – as *Plant Nematodes, Their Bionomics and Control.* In this Dr. Christie has summarised, in something under 250 pages, what is at present known about the life cycles, ecology, injuries to host plants and control of nematodes. He does not include taxonomy and morphology. While it is difficult to single out one section of this book as being of greater interest than any other, it may well prove to be the chapter on control that will attract most attention, for this chapter summarises all the available information on plant nematode control and, in the case of chemical control, provides a particularly useful guide to choosing between the various nematocides now on the market.

Plant Nematodes may be considered as consisting of four parts, although they are not described as such. First, there is a good introductory chapter which describes plant nematodes, their biology, their natural enemies and the symptoms of damage which they cause to plants. There follows a very complete account of control methods, after which come a series of chapters dealing with practical aspects of specific groups of nematodes. Finally, there is an

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[2] 'Nemagon' is a Shell registered trade mark.

[3] *Plant Nematodes, Their Bionomics and Control*, by J. R. Christie. Published by the University of Florida, Gainesville, Florida, U.S.A. Price $3.75 domestic, or $4 foreign.

appendix containing a number of exceedingly useful tables.

In the introductory chapter, discussing symptoms of plant injury by nematodes, the author points out that, contrary to popular belief, most nematode species do not cause galling in plant roots; root galls are usually a symptom of injury by root-knot nematodes, *Meloidogyne* spp., although nematodes of *Nacobbus* spp. also cause galling on some plant species, and some cereals and grasses attacked by *Ditylenchus radicicola* develop small root galls. Many other nematode species, including such external feeders as the dagger nematodes, *Xiphinema* spp., may cause moderate swelling of the roots, which, if localised, results in small enlargements similar to galls.

Dr. Christie also points out that often the symptoms of nematode attack seen on a plant are, in fact, the result of attack by several different nematode species, and also that the same nematode may produce different types of symptoms in the same plant; then he reminds us that nematodes may increase the susceptibility of crops to attack by other organisms. Cotton, as is well known, may suffer from a combined attack by nematodes and Fusarium wilt, and cauliflower disease of strawberries is caused by a bud and leaf nematode (*Aphelenchoides* spp.) in combination with the bacterium, *Corynebacterium fascians*.

Methods of control

Dealing with plant nematode control, the author lists and describes seven methods: heat (heat treatment of the soil and hot water treatment of the plants); fallowing; crop rotation; biological control; the use of organic matter and mulches; root diffusates; and chemical control.

Looking briefly at these various methods, it is clear that heat treatment of the soil is only possible on a small scale; hot water treatment is successfully used for controlling stem and bulb nematode, *Ditylenchus dipsaci*, on bulb plants (especially narcissi), but fibrous-rooted plants do not tolerate the treatment so well.

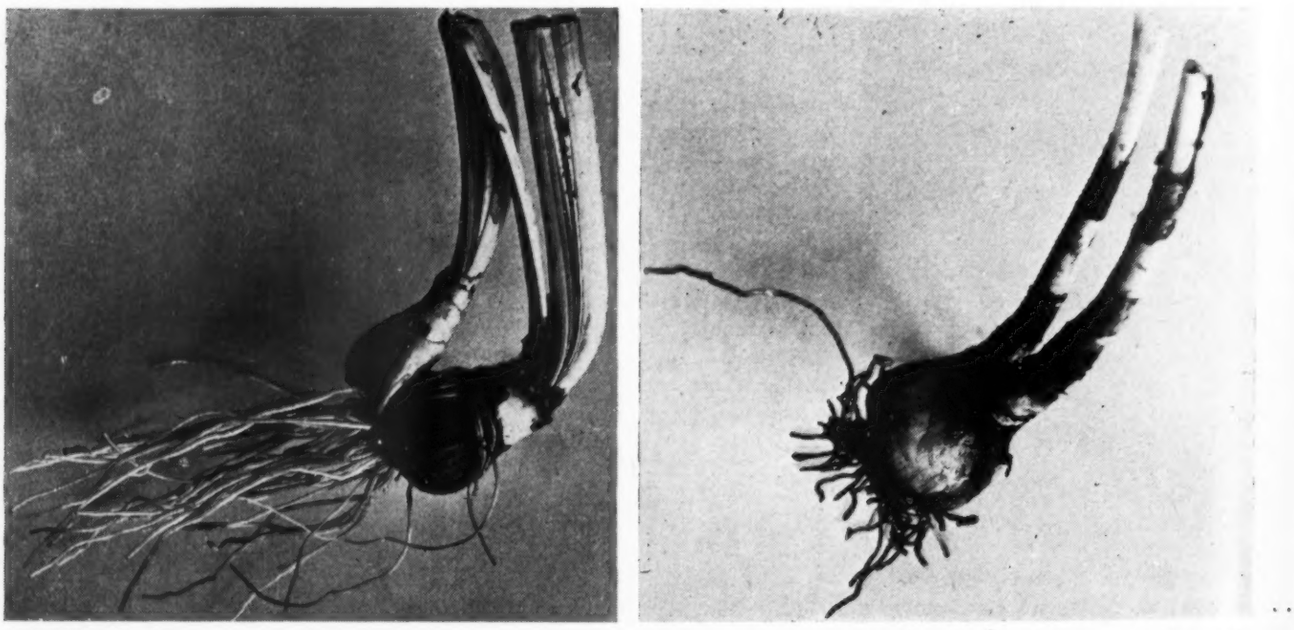
Fallowing, while it can be effective in controlling nematodes, is often not a practicable proposition. Where low-value crops are infested, a rotation which includes plants resistant to the nematode in question may be the only control method that can be used profitably.

So far as biological control is concerned, observations on the effects of certain predaceous nematodes (*Mononchus* spp.) on sugar-beet nematode, *Heterodera schachtii*, do not appear to have been very encouraging. The addition of organic matter to the soil, however, either by mixing it in or by applying it as a surface mulch, has in many cases reduced the severity of nematode damage to crops. Pot trials with various species of 'trapping' fungi, which are known to kill nematodes, have been carried out on root-knot infested pineapple plants, but the results were not encouraging – possibly on account of unfavourable environmental conditions.

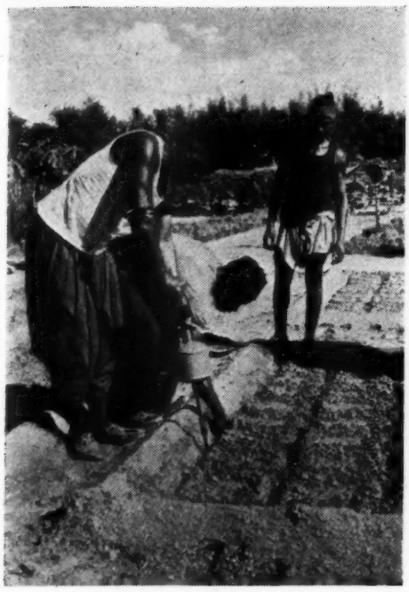
Certain excretions, or diffusates, from plant roots are known to influence the behaviour of plant parasitic nematodes in different ways. While investigations carried out so far do not seem to have reached a very advanced stage, Dr. Christie believes that there are various ways in which the effects of root diffusates might be used for nematode control, particularly in connection with rotations and cropping practices. He points out that the possibility of identifying and synthesising the active principles in root excretions looms in the background.

Control by chemicals

More space is devoted to the chemical control of nematodes than to all the other control methods together, and the author provides an admirable review of the subject. He sets out by explaining that two main difficulties are involved in controlling nematodes by chemicals: first, there is the problem of finding an effective material, because nematodes are resistant to most chemicals; secondly, there is the difficulty of applying these chemicals.



Daffodil bulbs grown in the Scilly Isles. Left: *bulb grown on land which had been treated with D-D; note the clean and prolific root system.* Right: *bulb heavily infested with* Ditylenchus dipsaci; *note the withered and blackened roots*



Injecting soil fumigant into a test plot in French West Africa

It was at one time fashionable to postulate the properties required in a chemical to make it an ideal soil fumigant; now, as Dr. Christie observes, 'it is becoming increasingly obvious . . . that there is no such thing as an ideal nematocide or even an ideal soil fumigant. A chemical with properties that would make it ideal for one purpose or use under one set of conditions might make it quite unsuitable for another purpose or use under another set of conditions'.

There follows a useful account of the principal soil fumigants now in use and the applications for which, in the author's opinion, they are best suited. Thus D-D[4] is considered more effective than ethylene dibromide for controlling cyst and lesion nematodes, whereas EDB[5] is reported to give more effective control of sting and stunt nematodes. Again, 'Nemagon', which on account of its low phytotoxicity can be applied around the roots of many plants, is referred to as apparently functioning more effectively than other fumigants at high soil temperatures.

Methods of application

One of the biggest problems in the application of chemicals for the control of root-infesting nematodes is that of bringing the chemical in contact with the nematode, and in this book the author gives the 'pros and cons' of the three methods used: gaseous diffusion through the soil of volatile liquids; dispersion through the soil in water; and mechanical mixing. He then gives practical advice on soil fumigation.

The major part of *Plant Parasitic Nematodes* is devoted to 12 comprehensive chapters on the various groups of nematodes encountered as plant pests. Each group is dealt with in broadly the same way, under such headings as Introduction, Life History, Feeding Habits, Injury to Plants, Hosts, Nature of Resistance in Plants, Distribution and Spread, and Control. These chapters, like the others in the book, all end with a complete list of references.

Finally, there is the appendix, which for rapid reference may prove to be the most useful part of this useful book. It consists of five tables. In the first, a number of crops is listed, with the nematodes associated with each and the regions (chiefly in the U.S.A.) where damage is known to occur. Table 2 sets out control methods for different nematodes infesting various crops. Table 3 gives details of hot water treatments for killing nematodes on planting stock; and the last two tables list, respectively, the common and scientific names of nematodes.

This book deserves to become a *vade mecum* for all field nematologists; one hopes that it will receive the widest possible attention.

[4]D-D: 1,3-dichloropropene and 1,2-dichloropropane.
[5]EDB: Ethylene dibromide.

Aerial Farming in N.Z.

A plea for organised industry and the establishment of a standing research committee was made by the New Zealand Director of Civil Aviation, Sir Arthur Nevill, addressing a national agricultural aviation symposium at Wanganui.

In the year ended March 1959 there were 396,000 tons of fertiliser dropped on 3½ million acres, which represented a decline of about 15% on the previous year. Aerial spraying had almost doubled, the gallonage rising from 724,000 in 1958 to 1,160,000 in the year. Total hours flown by aircraft in the industry were 67,500 with 249 planes, as against 80,900 hours with 269 aircraft in the preceding year.

Advice by Air

In the north of Norway the farm holdings are widely scattered along the valleys, fiords and the long coastline. Most advisory work is carried out by personal visits to individual farms and with counties about the size of Denmark, containing a widely dispersed population of smallholders, fishermen and Lapp reindeer owners, a great deal of time has to be spent driving by car to such inaccessible places in remote regions.

Henrik Tveit, a district agricultural adviser working in Finnmark, between 68° N and 71° N, the most northerly county in Norway, is using a Piper Cub plane this year for his work.

Lakes, fiords and rivers make it possible for him to go direct and to take off and land close to any required destination. In summer his plane is equipped with floats; in winter with skis.

Spraying in London

Agriculture was made the theme of this year's Lord Mayor's Show, the traditional pageant which has been seen by so many visitors to England.

Helicopters accompanied the pageant for the first time in its history; controlled by a radio car they flew low over the Thames and sprayed coloured water in a demonstration of crop spraying staged by the National Association of Agricultural Contractors. The whole pageant was arranged by the National Farmers' Union and other organisations taking part were the Agricultural Engineers' Association, the Association of British Manufacturers of Agricultural Chemicals, the Fertiliser Manufacturers' Association and the National Association of Corn and Agricultural Merchants.

Weed Conference, 1960

The British Weed Control Council has announced that the Fourth Weed Control Conference will be held at the Grand Hotel, Brighton, from 7–10 November, 1960. Applications for membership and all enquiries should be addressed to the Secretary, The Weed Control Conference Committee, 52 Bedford Row, London, W.C.1.

Fields of pyrethrum flowers

The Breeding of Improved Pyrethrum Varieties

U. KROLL,* PH.D.(AGR.)

This is an account of the breeding work being done by the Department of Agriculture and the Research Station of the Pyrethrum Board working in close collaboration. It will be found of great value to botanists and plant breeders working in other countries on other crops.

THE sources of Kenya pyrethrum were seed imported from Dalmatia, its natural habitat, Japan and Britain about 1931. No breeding work had been undertaken on any of these provenances, so that a great variation between types for growth habit as well as pyrethrins content is only natural. While such characters as prolific flowering and resistance to certain diseases are easily recognisable, external markers indicating the degree of toxicity in the flower do not exist. It follows, therefore, that the work of the chemist is closely bound up with that of the breeder. Happily, collaboration is ensured through the Pyrethrum Board's laboratories in Nakuru.

Desirable characteristics

The first step in the breeding work is the selection of individual plants which show such visible desirable features as upright growth habit (for ease of cultivation and picking), vigour, heavy flower yield and comparative freedom from diseases. Such plants are divided into splits and planted in clonal rows for further observation. Most of these single-plant selections are made within collections of hybrids bred on the various research stations; this ensures knowledge of their parentage and the possibility of line-breeding, back-crossing etc., if this is desired.

As pyrethrum normally is a three-seasonal crop, it appears essential to test the performance of all breeding material over not less a time than this period. Only plants are retained which give satisfactory yields for three subsequent seasons. The clonal rows are picked at regular intervals, number and weight of flowers recorded, diseased buds counted and at least three times during each season flower samples sent in for determination of the pyrethrins content. It may be desirable to analyse each picking, but this would not be possible with the present laboratory facilities.

The clones are evaluated and either kept for further observations or discarded. The percentage eventually retained is low, not more than 5%, and continuous selecting year by year is therefore necessary, apart from the fact that one would expect to make selections within gradually improving material as time progresses.

Clonal selection too slow

Clones which have been tested in the described manner and found to excel in the desired characters could, of course, be issued to growers for further vegetative propagation, and this has, in fact, been done on a certain scale. This process is, however, too slow for the demands of several hundred growers (the total pyrethrum acreage is approximately 23,000) who have to be supplied with improved planting material, and so the next move for the breeder is usually the production of hybrids with the view of seed issue to the farmers.

While this technique has been in use ever since breeding began in Kenya, extensive studies were at the same time undertaken by the writer and his assistants on pollination and seed-setting, which have proved that pyrethrum is predominantly cross-pollinating, that, in fact, only a very small percentage of seed is produced through selfing and that even under conditions otherwise favourable for cross-fertilization, seed-setting is poor

* Department of Agriculture, Kenya.

unless pollen-carrying insects are available in sufficient numbers. Apart from the fact that only a negligible seed harvest would be gathered from a clonal plantation, the ensuing generation would still vary in type and performance as the offspring of a normally outbreeding, heterozygous plant.

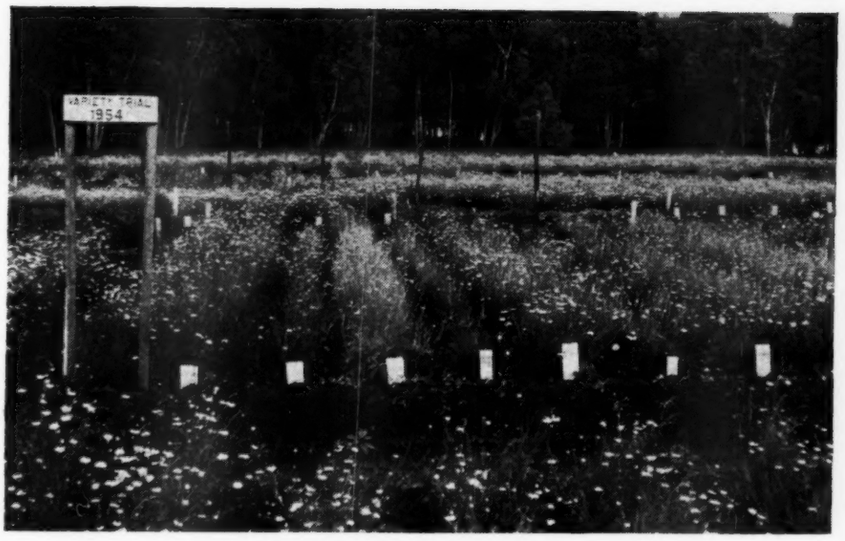
Production of hybrids

Hybrids are being produced as crosses between either two or more clones (polycrosses). Most of the improved varieties issued so far are hybrids of two clones. Different combinations are used for pairing. So, for example, a clone which excels in vigour can be crossed with a high-content one, or two clones of the same group are brought together. Apart from these methods, back-crossing to one parent and line-breeding (two clones being hybrids of the same origin) are being practised. It is generally found that the pyrethrins content can be raised in the hybrid by using one parent clone with a high pyrethrins percentage, this apparently being a dominant character.

The hybrids, as a rule, although genetically a mixture of types, present a fairly homogeneous population. By collecting seed from either parent separately and comparing the ensuing siblings† a further check can be made on effective cross-pollination.

All new hybrids – about 20 are produced year by year – are tested in yield trials and compared with a standard variety at different altitude levels on the various experiment stations placed over the Kenya Highlands.

† Sibling: offspring having one or both parents in common.



Variety/yield trial with hybrids

These trials again last for three seasons and any hybrids showing outstanding qualities are then produced on a field scale. This means that first the parent clones will have to be propagated vegetatively until sufficient material is available to plant up, say, half an acre, which would normally yield 100 lb. to 150 lb. of seed per year.

The time factor

The selecting and testing of the original breeding material and the production and testing of the hybrids take, therefore, seven years. Allowing a certain time for the propagation of the parent clones – even if started before the final results of the three-season yield trials – and for the full establishment of the seed production field, a minimum of nine years will elapse before a new variety can be issued. Only the first cross, the F.1 generation, is used and growers are warned not to make a further cross, F.2, as too many undesirable types would have to be expected through segregation.

Production of polycrosses

Polycrosses are produced chiefly by a system which is similar to the one employed by the sugar-beet breeders. The genetical basis is broader as a number of tested clones (six to 10) is planted in isolation plots and these are allowed to cross-fertilize. The F.1 generation of each individual plot is then planted again under isolated conditions, but less desirable plants are culled and seed collected after the second season from the best types only. Their offspring, F.2, is again treated in the same way, so that a certain amount of line-breeding takes place within the various generations of the original polycrosses.

After a certain period all seedlings are mixed and a large polycross is made and, after testing its performance, issued to the farmers. It is hoped that some hybrid vigour will occur. The breeding plots, however, are kept up and further culling takes place in each succeeding generation. Then, seed issues are made biennially from, it is expected, gradually improving material.

The first seed from these systems – one for the higher and one for the lower altitude ranges – is being produced on a field scale in 1958–59; it cannot be stated yet, therefore, how successful this will be.

Recording the crop of pyrethrum flowers

Polycrosses have proved of great value as a source for new material. So, for example, the only useful polyploid plant registered up to date at Molo originates from the ' sugar-beet ' system.

The ideal plant

While in the preceding paragraphs an outline of the breeding technique is given, various other aspects should be considered as well. One snag with two-clonal crosses, which was discovered in the early stages of the work, is partial or total incompatibility. Occasionally only one clone will be fertilized, while the second produces no viable seed. For the purpose of seed issue such a combination has to be avoided. Risk of this occurrence is, of course, minimised in polycrosses.

The ideal plant would obviously be one with a very heavy flower yield, a good average flower weight to facilitate picking and a high toxic content. Correlations have shown a negative relation between number and size of the flowers on the one hand and flower yield and content on the other.

Although, as will be pointed out later, various combinations of clones have produced hybrids with a greatly improved yield of pyrethrins, it appears that in the best of cases a compromise has to be made. It has, however, been the aim over the past years not to sacrifice vigour. Vigorous plants are better able to withstand adverse conditions and to produce a satisfactory yield in spite of flower and other diseases.

Breeding for disease resistance

Two main bud and flower diseases are known to influence the yield. One is caused by the fungus *Ramularia bellunensis*, while the other is of a purely physiological nature, probably the result of a certain weakness in the plant; little is known at the moment about this last. Extensive studies, on the other hand, have been undertaken on the causes and the behaviour of *Ramularia* disease. At present no really effective fungicide is known, therefore selecting and breeding for resistance are considered the most efficient means to combat the trouble.

Although a great variation in resistance or susceptibility to the fungus occurs between clones, none completely immune has yet been discovered. So back-crossing to such a plant, which would help in the fight against the disease, is not possible and the breeder has to content himself with a relatively high resistance enabling the plant to live with the disease.

Correlations calculated between flower production and bud disease rate have given clear indications that weaker plants suffer to a greater extent. In general, clones which show a higher disease rate than 5% (expressed by the proportion of diseased buds and flowers to the number of healthy flowers) are eliminated. Only at the very high and cold altitudes (9,000 ft.) has a higher percentage to be tolerated provided the plant is a heavy flowerer.

Need for chilling

To initiate bud protection a certain degree of ' chilling ' is necessary. In Kenya this usually coincides with the beginning of the rains, when mean temperatures fall below a certain critical point. The chilling requirements differ between individual plants and varieties (hybrids), and to test the optimal conditions for their flower production a series of research stations has been established at altitudes of 7,000, 7,800, 8,200 and 9,100 ft. respectively.

Selecting and breeding are carried out on all these stations and, in addition, variety/yield trials are also planted on farms which are representative for certain areas. While in the warmer altitudes the production of well-flowering hybrids is the chief aim, in the colder places selection against bud diseases presents the major problem.

Some success with the production of varieties for the lower ranges has been achieved and, provided rainfall is sufficient, heavily yielding fields well below the 7,000-ft. mark can be observed today. The pyrethrins content, too, is influenced by mean temperatures and is usually higher at the colder altitudes. It is therefore more difficult to breed high-yielding and high-content varieties for the lower ranges than for those around the 8,000-ft. mark and over.

Variation in pyrethrins content

Another peculiarity of the pyrethrum plant creates certain problems for the breeder, and this is the variation in total pyrethrins content, as well as in the pyrethrin I : pyrethrin II ratio which often occurs from picking to picking. The true value of a clone or hybrid is difficult to assess, and this has been so especially while a high proportion of pyrethrin II was under suspicion.

The latest chemical work has, however, shed more light on the relative efficacy of the different constituents and future breeding work may have to consider the production of varieties with predominantly the one or the other of the pyrethrins for specific insecticidal purposes.

Artesian Water Resources

The development of underground water resources was very important to Australia, the Minister for National Development, Senator W. H. Spooner, said when he opened a Federal-States Conference on Underground Water in Sydney recently.

About 70% of Australia had a rainfall of less than 20 in. a year. In parts the rainfall was as low as 4 or 5 in. and of uncertain incidence in any one year. In this vast area of low rainfall, extending into all mainland States, evaporation was extremely high and water stored in the ground was often the only continuous source of supply.

Australia was fortunate, he said, to possess the largest artesian basin in the world – the Great Australian Basin of 670,000 square miles. Together with other extensive basins this covered much of the semi-arid and desert regions of Australia.

Eighty years ago the first artesian bore in Australia was put down at Kallara Station, near Bourke. Since then well over 10,000 such bores have been drilled.

The finding of new sources of underground supplies and the further development of known resources will enable larger areas of inland Australia to be more profitably used in producing wool and beef or will assist mineral prospecting and development.

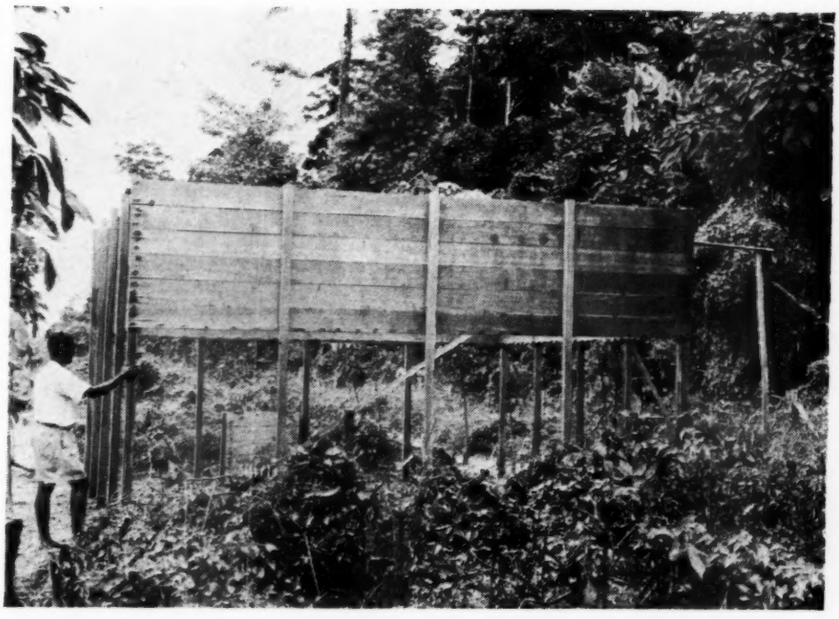
At the present time at least 20% of the sheep population of Australia and a large number of cattle are entirely dependent upon artesian supplies.

Control of Animal Pests in Rubber

NEW clearings, especially those bordering jungle or belukar, and even replantings and nurseries containing young seedlings, are exposed to occasional ravages of a number of warm-blooded animals, ranging from the elephant to the rat. Most of these animals have their home in the jungle and enter cultivated areas only exceptionally, but a few, such as rats and some species of squirrels, are permanent inhabitants of cultivated areas.

Though specimens are frequently received from estates showing different types of damage, knowledge of the identity of the culprit is by no means complete, for it is difficult to make direct observations of a pest out on the jungle edges, particularly at night, where a nocturnal pest is concerned.

A permanent fence is the most effective method of protection against the majority of the larger animals which have their normal habitation in the jungle, but the expenditure involved in erecting a useful one is heavy. Electric fencing, a cheap alternative which was developed for enclosing domestic animals, has sometimes given poor results when tried for excluding wild animals and is difficult to maintain on jungle boundaries. It has been claimed, however, to work successfully against elephants.



Monkey trap erected on the edge of the jungle. The seesaw allows him to enter, but not to get out again

For other pests alternative methods of protection are usually adopted.

Elephants. – Elephants cause damage in young plantations usually by trampling and partly through their apparent wanton habit of breaking plants off. Prior to the war it was a common practice to leave an 'elephant belt' of one chain of felled but uncleared jungle round the boundaries of a clearing to prevent the elephants from entering the rubber. Fencing is now generally resorted to where elephants are prevalent. Electric fencing is claimed to give satisfactory protection.

Monkeys. – Monkeys may damage rubber wantonly by breaking off branches and tearing leaves. Some of them will also eat the seed pods, bud shoots and young leaves, the leaves being usually bitten through, part being left undamaged.

Shooting is considered the best control and if the carcasses are hung up in the area they will act as the best deterrent to the rest of the troupe. Monkeys can also be trapped in a large cage of the enclosure type, constructed out of wire-netting and planks, which is provided with a seesaw device within that prevents their escape. Another method is to smear the brown bark of perimeter trees, in immature areas, with a tanglefoot preparation which would stick to their fur. It has also been reported that monkeys can be frightened away by trapping one of them alive, sewing a piece of bright cloth around its body and then releasing it.

Deer. – Deer produce a most characteristic form of damage by stripping bark from trees from a short

Leaves of the rubber clone, Glenshiel 1, damaged by a flying fox

distance above ground level to about 5 ft. They may also eat the tops of small plants. Trees completely ring-barked may recover, but growth is usually poor and the renewed bark is rough. More often than not, especially if the trees have heavy crowns, the trunk breaks off before bark renewal is complete. Where the damage is not so severe, trees can usually be saved and a light application of a petrolatum will hasten bark renewal.

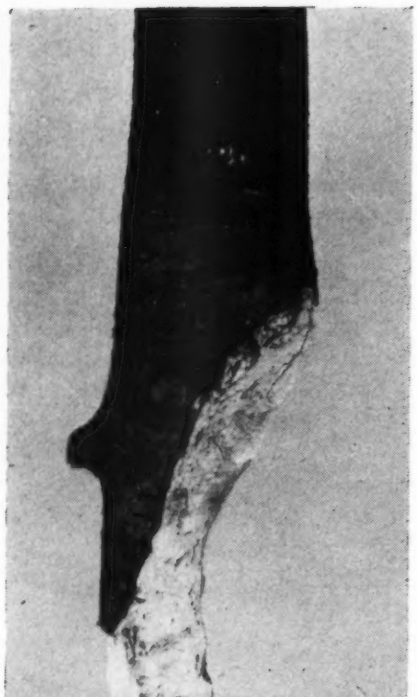
Without fencing, protection of plants in areas prone to incursions of deer is not easy, but the erection of a deer-proof fence, which must be at least 5 ft. high, is rarely an economic proposition. The alternative is to attempt to discourage them from eating the bark by the application of a repellent substance. A number of materials which have been recommended from temperate countries, applied either directly to the bark or to pieces of sacking hung around in the area, have not succeeded in repelling deer in Malaya.

Encouraging results have also been claimed following the application of an aluminium paint band 2 to 3 ft. wide round the tree. Also black tar spots on the bark, later alternated with white spots, have been claimed to give some protection. Of a number of repellents, the only one which gave any indication of promise was a black bitumen emulsion (Shell ' Flintcote ') when applied from ground level to the height of the lower branches. Game-scarers, which give intermittent explosions, are fairly successful against peer.

Wild pigs. – These animals tear stumps and seedlings out of the ground and feed on the roots. They may also occasionally damage seedlings when rooting for grubs and rubber seeds. Where shooting is not carried out, the usual method of control is by poisoning, using sodium arsenite baits. As this is a dangerous poison, strict adherence to safety precautions is important. Tapioca root, sweet potato or any other food to which wild pigs are partial may be used for preparing the baits.

Rats, squirrels and porcupines. – These are all rodents and often cause considerable damage in nurseries and young plantings.

Rats and squirrels operate all over the country and are most numerous near oil palm and coconut plantations. They thrive abundantly in clearings where felled timber has been stacked and left to decay on the ground. In coastal areas rats can be troublesome in replantings. Porcupines, on the other hand, come from the jungle and uncleared ravines.



Base of a 2½-year clonal seedling, showing how the tap root has been gnawed by a rat

Germination beds and seedling nurseries are often the scene of concentrated attacks by rats or squirrels, the seed kernels and the very young shoots being entirely consumed. Rats usually consume the seed on the spot, while squirrels carry it away to eat, and this fact gives a clue to the identity of the pest. Where young seedlings are attacked, the distinction is not so easily recognised and it may not be possible to pin-point the culprit without additional evidence. The seedling may be bitten off a few inches above ground level and the stem of the upper portion split to expose the pith which is consumed. Stems of older seedlings may only be partly cut across, the cut half split from the rest of the seedling upwards or downwards, so that the pith can be eaten.

All three pests have been known to gnaw bark at the base of younger seedlings and buddings. Squirrels will also nibble the cortical tissues of small branches and even the renewing bark on the panel.

Before control measures are attempted it is desirable to determine the identity of the culprit and to this end traps should be set. Dried fish heads or prawns are attractive baits for rats; fruit or rubber seed for squirrels, and salty bacon for porcupines.

If damage is not extensive, trapping alone may suffice to dispose of the pest. Many protective devices, such as guards made of pieces of split bamboo or wire-netting of small mesh and tin cylinders have been tried. Where damage is extensive the most practical procedure would seem to be the application of a protective dressing, such as zinc phosphide and coconut oil in a 50 : 50 mixture by weight, or a tanglefoot preparation which can be obtained as a ready-made mixture or made by taking four parts of raw linseed oil, boiling until thick and tacky and then adding one part of castor oil and one part of powdered damar resin.

These dressings are liable to scorch green bark and should therefore be applied to paper guards wrapped round the stem when used on very young seedlings. When applied to brown bark no damage will result unless zinc phosphide is applied too thickly. All that is required is a very light smear to the basal few inches of the brown wood on seedlings or stumps.

The above dressings are usually considered as deterrents and a convenient way of disposing of these pests is by poison baiting. A number of materials have been used, such as thallium sulphate, sodium arsenite, white arsenic, barium carbonate and zinc phosphide, but with limited success. Recently a kind of poison which has the merit of eliminating bait shyness – the reason for the failure of most poisons – has been discovered, warfarin being the one that is locally available under the trade names of ' Warfarin 5K ' and ' Sorexa '. These are concentrates, to be mixed with 19 parts by weight of some acceptable food.

Tree shrews. – The tree shrew has been recorded attacking young buddings and the damage is characterised by pin-pricks exuding latex on the developing bud shoot and by the young

shoot being cut through and partially consumed.

If trapping is resorted to in controlling tree shrews, fruit provides a suitable bait. Protective measures, as discussed under rats, squirrels and porcupines, can be successfully applied to control this pest also.

Flying foxes. – Occasionally flying foxes feed on rubber leaves, and, oddly enough, confine their attentions to the one clone Glenshiel 1, other contiguous clones being left untouched. They generally choose the outermost leaves, which are torn off and eaten. Chewed 'quids' composed of the veins and midribs, spat out after the soft parts have been consumed, are frequently seen under affected trees. There is a record of damage so severe that some trees were completely defoliated with only the tattered portions of the leaves remaining on the stalks. Although control measures have not been tested in Malaya, trapping by means of large nets suspended above the trees has been reported to be successful in Ceylon, where such attacks are more common.

Abstracted with permission from the *Planters' Bulletin* of the Rubber Research Institute, Malaya.

Fruit in Rhodesia and Nyasaland

W. L. SPEIGHT

BY far the greater proportion of the fruit produced in the Federation of Rhodesia and Nyasaland comes from the three citrus estates of the British South Africa Co., namely, Premier Estate at Umtali, Sincia Estate and Mazce Citrus Estate. These estates now have some 123,000 citrus trees, producing 11,000 tons of fruit – oranges, lemons and grapefruit – annually.

Photos: Rhodesia & Nyasaland Inf. Centre

Gathering oranges in Southern Rhodesia

Citrus

In addition, the new Hippo Valley Estates were started in 1956. By August 1957 some 1,000 acres of land had been cleared and the planting of a further two million trees is contemplated. These orchards will be irrigated from the Kyle Dam, which is to be erected near Fort Victoria by the Southern Rhodesia Government.

The bulk of the crop grown on the Mazce Citrus Estate is processed by a modern plant on the estate, which produces concentrated juice and other citrus derivatives. Trailers collect the fruit in bulk from the orchards, and the fruit is then automatically dumped into a receiving hopper and carried by conveyors to storage bins. Afterwards water conveyors carry and wash the fruit before processing.

Oil and juices are in most cases extracted mechanically and the residue of the fruit is turned into cattle meal. The principal products of the estate are the concentrated juices, and during last season the output was 102,000 gal. In addition, 9,000 gal. of natural fruit juice, 40 tons of orange, lemon and grapefruit oils and 800 tons of citrus cattle meal were produced. This estate also has its own laboratories, where research and quality control in the factory are carried out. Water for the orchards is supplied by the Mazce Dam, which has a capacity of 5,000 million gal. and supplies 805 acres.

The bulk of the exports of citrus products from the Federation of Rhodesia and Nyasaland go mainly to Britain, but smaller amounts of concentrated juice are sent to East Africa, and the orange and lemon oils mainly to Australia and South Africa.

Apples and pears

There has been a phenomenal development in the home fruit industry, and apple and pear production is soaring. According to the Deciduous Fruit Board, production is expected to more than double itself within the next 10 years through improved agricultural methods and new plantings.

Loading the harvested fruit on to the trailer for transport to the packing shed

Improved methods

Individual tree yields are being increased by the introduction of sprinkler irrigation, the use of trace elements – zinc and manganese – and better soil management. The orchards are being extended at a fantastic rate; since 1945 about 2 million apple trees have been planted in Elgin, Langkloof and Koue Bokkeveld and at the present rate of progress it is estimated that there will be about 9 million trees in 1970. Of the 1.4 million pear trees already planted, over half have yet to come into bearing. So it can be expected that production will more than double itself. The same applies to apples. In 1945, 1 million bushels were harvested; production rose to 1.8 million in 1950 and in 1958 the yield was 4.7 million bushels. By 1960 it is expected that the crop will exceed 6 million bushels. The Board is naturally taking steps to expand its markets, particularly in Europe.

Fruit varieties

The pear varieties produced are mainly 'William's Bon Chretien', which meets the requirements of the canning industry, and 'Packham's Triumph'. Apple plantings are mainly confined to a few popular varieties – red, golden and green. They are the 'Golden Delicious' and the 'Starking', which is better suited to the climate, and among the green varieties both 'Granny Smith' and 'White Winter Pearmain' are favoured.

NOTE FOR CONTRIBUTORS AND AUTHORS

The editor welcomes authoritative articles and news items on agricultural machinery and agricultural methods, agricultural crops and new developments.

A short synopsis should preferably be included to assist the editor and the manuscript itself should be typed in double spacing with plenty of margin and on one side of paper only.

It should bear the name and address of the author and be accompanied by sharp photographs or line drawings with suitable captions.

Flying Three-day Visit to Britain

Twenty-seven eminent agronomists – principals and professors of agricultural colleges in Belgium, Denmark, Eire, Finland, France, Germany, Holland, Iceland, Norway, Portugal, Sweden and Switzerland – recently visited the Ford tractor works at Dagenham, England, the Mechanical Farming Centre at Boreham in Essex and the Wye Agricultural College in Kent as guests of the *Ford Motor Co. Ltd.*

The distinguished visitors gathered round a Fordson Major tractor

Crop Protection by Seed Treatment

1—Seed Dressings for Cotton

S. A. J. TARR,* B.SC., PH.D.

The application of chemicals to seed in order to destroy harmful moulds, bacteria and insects is called seed dressing. This article describes the treatment of cotton seed, fodder bean seed, groundnuts, millet (sorghum or durum) and the cereals – maize, wheat and barley

Photo: Caterpillar Tractor Co.

Healthy cotton defoliated and ready for harvesting

FUNGICIDAL treatment often protects seed and seedlings from harmful soil micro-organisms, chiefly fungi, which may attack them during the critical period between sowing and their establishment as emerged seedlings with functional roots and leaves; it thus encourages even stands, vigorous early growth and higher yields, which more than pay for the relatively modest cost of treatment. Such seed dressings are now extensively used to improve emergence in a wide range of crops.

Fruitful field of research

Inclusion of insecticide in the dressing may protect the seed (both during storage and when sown), seedlings and young plants from the depredations of certain soil-borne and air-borne insect pests and combined fungicide-insecticide seed treatment is now coming into extensive use. New fungicides, bactericides and insecticides of greater potency and persistency are being discovered, systemic insecticides are now being successfully used in agriculture and systemic fungicides are being developed. The application of these new crop protection chemicals as seed dressings is an interesting and fruitful field of research likely to yield results of value to farmers all over the world, and the scope of seed treatment as a crop protection measure will steadily increase.

Seed treatment of temperate crops, particularly cereals, is extensively practised and its application in tropical and sub-tropical areas is now being investigated. Available space does not permit a review of the literature, but the results obtained in the Sudan during recent years perhaps exemplify the progress which may be expected in other tropical areas when the possibilities of seed treatment come to be systematically investigated. Much of the Sudan research concerned irrigated crops grown in the Gezira – the extensive clay plain lying between the Blue and White Nile rivers south of their junction at Khartoum – and included cotton, sorghum, dolichos bean, groundnuts, maize, wheat and barley.

Seed treatment for cotton

Cotton is by far the most important cash export crop of the Sudan. Blight (' blackarm '), a destructive seed-borne bacterial disease, can cause heavy losses to Egyptian-type cotton, *G. barbadense*, in the Gezira, and probably the most important single measure for its control is seed treatment. For many years ' Abavit B ', a powder seed dressing containing about 5.7% mercury equivalent as mercuric chloride-iodide, has been used, but recent investigation has shown that better control is obtained by using a fortified ' Abavit ' preparation of about 8.5% mercury content. Per unit of mercury, several organo-mercurial compounds, notably MEMA, methoxyethylmercuriacetate, were significantly more effective than mercuric chloride-iodide.[1]

Methods of application

Methods of applying the bactericide to the seed were also studied, and slurry or short-wet methods, in which a small volume of relatively concentrated bactericidal suspension or solution is rapidly mixed with the seed, were found to be more effective than powder treatments.[2] To ensure adequate wetting of seed lots containing intermixed lint the fairly high application rate of 50 c.c. of bactericidal liquid per lb. of seed (about 11%) was adopted, treated seed drying almost immediately in the hot, dry climatic conditions prevailing in the Gezira at time of treatment.

In trials with heavily infected seed over several seasons short-wet treatment with MEMA solution applied at

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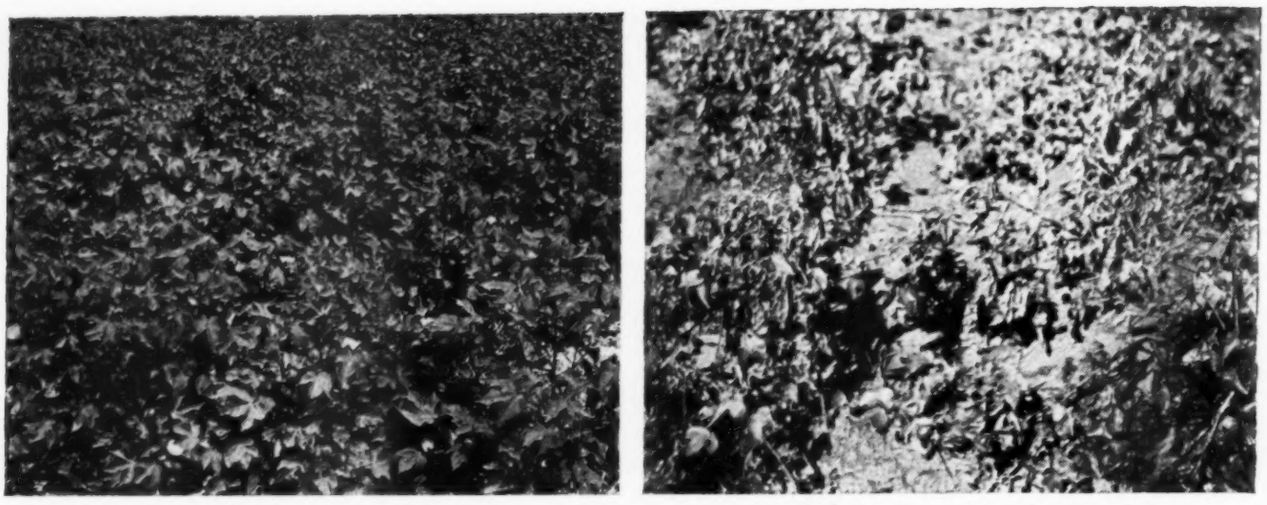

Left: *vigorous healthy cotton.* Right: *cotton severely attacked by bacterial blight. Note withered broken plants*

0.043% mercury/seed resulted in about 60 infected seedlings per acre, as compared with about 150 for 'Strong Abavit' powder (0.057% mercury/seed), 700 for 'Abavit B' powder (0.037% mercury/seed), and more than 50,000 for untreated seed. Other advantages of MEMA short-wet treatment are that disinfection occurs at the time of treatment, the bactericide adheres to the seed as a tenacious film, and flying bactericidal dust is virtually eliminated.

In large-scale application the MEMA solution was sprayed over the seed whilst it was in continuous motion inside a power-driven revolving drum, with subsequent thorough mixing for 10 minutes; details are given elsewhere.[3]

Mercurials were by far the most effective bactericides in destroying seed-borne bacterial blight, with cuprous oxide the next best, resulting in several thousand infected seedlings per acre. This latter degree of control would be inadequate in the Gezira, where climatic and agricultural conditions are highly conducive to rapid development and spread of the disease, but is acceptable in places less favourable for it – and cuprous oxide treatment of cotton seed is widely practised in Uganda, Tanganyika and other areas where the use of poisonous mercurials is deemed inadvisable.[4,5]

Dual-purpose seed dressings

In preliminary experiments with combined bactericide-insecticide seed dressings there was evidence that inclusion of γ-benzene hexachloride (BHC) could give protection against flea-beetles, *Podagrica* spp., and possibly other insects which attack the aerial parts of cotton seedlings in the Gezira.

In other experiments it also gave protection against root and hypocotyl attack by termites, thus improving stands, growth and yields; in this respect BHC appeared to be somewhat less effective than dieldrin, and even MEMA alone (but not 'Abavit' alone) gave slight protection and may have mild insecticidal or insect-repelling properties. The insecticides were applied at 0.12–0.24% by weight to seed (15–30 g. per acre), and at the higher dosages the combined dressings were sometimes slightly phytotoxic.

Further research along these lines will almost certainly confirm the value of bactericidal-insecticidal seed treatment as a method of improving crop establishment and early growth of Gezira cotton.

Use of Systemics

Particularly does this appear likely to be the case with systemic insecticides; thus in the U.S.A. and Brazil such systemic insecticides as 'Thimet', 'Di-Syston' and schradan, applied as seed dressings at rates equivalent to ½–1 lb. of active ingredient per acre, controlled aphids, *Aphis gossypii*, thrips, *Frankliniella* sp., and spider mites for 4–10 weeks after sowing, and showed promise against flea-beetles, leaf hoppers, leaf miners, whiteflies, beetles, cutworms and certain other insect pests.

Current systemic insecticides are mostly organo-phosphorus compounds highly toxic to mammals and thus requiring extreme care in use, and the relatively heavy application rate often employed (sometimes up to 4% by weight to seed) may necessitate special techniques for sticking the insecticide to the seed, *e.g.* by mixing with activated charcoal and a small quantity of methyl cellulose as adherent.[6] The insecticidal and bactericidal components of the seed dressing must also be compatible.

Despite these various technical difficulties, there is little doubt that systemic insecticides applied as seed dressings will play an important part in protecting young cotton plants against insect pests, and the period of effective protection will be prolonged as more persistent insecticides are discovered. Their use against insect vectors of virus diseases is a further aspect of great potential importance.

Much information on insect control by seed treatment is given by Lange,[7] Reynolds *et al.*[8] and Reynolds,[9] and a review of seed treatment as a crop protection measure for cotton has recently been published.[10]

(To be continued)

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Technical Terms for the Layman

IN every occupation and profession there are certain words and technical expressions which constitute an essential factor in describing the tools, processes and phenomena involved. The field of agricultural chemicals is no exception – on the contrary, new words are being constantly introduced which the layman must comprehend for a further understanding of this complex new science.

Acaracides. Pesticide, specifically for the control of mites.

Aerosol. Air suspension of solid or liquid particles of ultra-microscopic size remaining suspended for long periods (hours or days), *e.g.* space fumigants for household or greenhouse use.

Aerosol sprays. For pesticide application should have considerable proportion containing particles ranging from 2 to 20μ in diameter. Aerosol bombs consist of pesticide material dissolved in low-boiling liquid, such as methyl chloride, propane or freon, and kept under pressure in metal cylinders etc. Release of valve ejects fine spray which leaves less volatile ingredients suspended in the air as minute particles upon rapid evaporation of the propellant (methyl chloride, freon etc.).

Aphicide. Pesticide specifically active in the control of aphids (plant lice).

Carrier. An inert type of material used to dilute or extend a dust formulation or sometimes spray formulations, *e.g.* bentonite, clay, diatomaceous earth, gypsum, pyrophyllite, talc, walnut shell flour etc.

Chlorosis. Yellowing or mottling of normally green tissue as a result of lack of chlorophyll, through its failure to develop or destruction by chemical effects, disease etc.

Compatibility. Ability of the pesticide to mix with other components of a formulation without separation or reaction impairing its pesticidal performance; mixing together without reduced pesticidal activity of one or more pesticides, *e.g.* DDT and lindane in sprays, DDT and BHC in dusts.

Concentrate. An insecticidal formulation containing a high percentage of active ingredient. For practical purposes any formulation containing an excess of 20% of the active ingredient on a weight basis.

Contact poison. A chemical that kills a pest on contact with external parts of the organism.

Control. Prevention of or reduction of loss from insect, plant disease, weed etc.

Defoliant. Chemical which causes the dropping off or shedding of leaves when applied to a plant nearing or at maturity generally to facilitate harvesting.

Diluent. A diluting agent used with concentrated pesticides to ensure broader coverage upon application than would be obtained if the pesticide was used alone, *e.g.* water in sprays, oils in some sprays, especially household types, finely-ground inert materials in dusts.

Disease. A condition in which any part of a living organism is abnormal.

Dormant. Plant stage in which growth and physiological activities have temporarily ceased or are reduced to a minimum, evidenced in many plants by loss of leaves.

Dust. An active ingredient or ingredients formulated with suitable carriers, diluents, extenders and grinding aids exclusive of granular or pelletised formulations.

Dust diluents. Relatively inert materials used to dilute pesticide products too concentrated for use alone; to serve as inert carriers upon which the pesticide may be carried or impregnated; and to condition pesticide dusts for more satisfactory application.

Emulsifiable concentrate. A liquid capable of forming a spray or dip emulsion when mixed with water; usually consisting of water-insoluble pesticidal chemicals plus surfactants, with or without solvents.

Emulsifying agent. Material added to a formulation facilitating the suspension of one liquid in another, decreasing the tendency to separate and increasing emulsion stability.

Emulsion. A dispersion of one liquid in a second immiscible liquid, *e.g.* oil in water etc.

Emulsion concentrate. An emulsion capable of forming a spray or dip emulsion when mixed with water; usually a viscous mixture consisting of water, water - insoluble pesticidal chemicals and surfactants, with or without solvents.

Emulsion spray or dip. A mobile emulsion of suitable stability exhibiting desired pesticidal action.

Epinasty. An abnormal downward curving growth or movement of a leaf resulting from more rapid cell growth on the upper side.

Fumigant. Liquid or solid substance that forms vapours or gases which destroy insects, pathogens etc., usually used in soils or enclosed structures, such as chambers, rooms, buildings, greenhouses etc.

Fungi. All non-chlorophyll-bearing plants of lower order than mosses and liverworts, such as rusts, smuts, mildews, moulds, yeasts and bacteria.

Fungicide. Any product intended for the killing or control of any fungi.

Grinding aid. An inert type material used to assist in grinding technical pesticides for formulation into dust concentrates, finished dusts or wettable powders.

Herbaceous. Non-woody plants which generally die down at end of growing season; may be annual or perennial.

Herbicide. Any agent or chemical for use in destroying, repelling, controlling or preventing weeds.

Herbicide, contact. Chemical which kills plant cells on contact, but does not injure plant parts not contacted. Includes vine killers and defoliants, *e.g.* sodium chlorate, sodium arsenite, petroleum oil, pentachlorophenol in oil, calcium cyanamide etc.

Herbicide, selective. Chemical which will kill some plants and leave others relatively unharmed, such as weeds growing in crop plants, *e.g.* 2,4-D, 2,4,5-T, sulphuric acid, dinitro compounds etc.

Herbicide, sterilant. Chemical applied to effect a complete kill of all plant life in treated area.

Herbicide, translocated. Chemical taken up by leaves or other plant parts and carried (translocated) to other plant parts, such as roots, stems etc., where it kills plant tissue and

finally the entire plant, *e.g.* 2,4-D, 2,4,5-T, ammonium sulphamate.

Host. Any plant attacked by parasite, such as an insect, fungus or bacterium.

Impregnated dust. One in which the pesticide active ingredient has been sprayed on or absorbed on an appropriate diluent either for a concentrate dust or a finished dust formulation on further dilution.

Ingredient, inert. An ingredient in a pesticide or its formulation which is not pesticidally active, *e.g.* water, emulsifying agent, diluent, carrier etc.

Ingredient, active. An ingredient which will prevent, destroy, repel or mitigate insects, fungi, rodents, weeds etc. The actual toxic agent in a formulation.

Insect. Any of the numerous small invertebrate animals generally having the body more or less obviously segmented and for the most part belonging to the class of insects comprising six-legged, usually winged forms as beetles, bugs, flies etc., and other allied classes of arthropods, wingless and usually with more than six legs, as spiders, mites, ticks, centipedes etc.

Insecticide. Any preparation intended for use in the control of insects, including closely allied classes, such as spiders, mites, ticks etc., or for repelling, mitigating or preventing any insect.

Insecticide, contact. A chemical causing death of insect with which it comes in contact.

Larvacide. Pesticide specifically active in the control of larval stages – grubs, worm, caterpillar – of insects.

LD_{50}. Symbol indicating the amount of pesticide necessary to kill 50% of the organisms in the test.

Lesion. Localised spot of diseased tissue.

Low volatile. Herbicide having active ingredient of low vapour activity, less hazardous than volatile types to foliage and crops nearby to area on which applied.

Micron. μ, 1/1,000 mm. or 1/25,000 in.

Necrosis. Death of plant cell or tissues generally obvious as change in colour or dried appearance or spots as in leaves.

Nematocide. Chemical or physical agents capable of killing nematodes.

Nematodes. Microscopic worms referred to as nemas, eelworms, roundworms, causing some plant diseases, found in moist earth, water and decaying matter.

Ovacide. Pesticide specifically active in the control of the egg stage of numerous insects.

Pathogen. Any organism capable of causing disease.

Pesticides. Substances used as insecticides, fungicides, rodenticides, herbicides, nematocides and acaracides.

pH. Symbol of scale designating relative acidity of a solution ranging from 1 to 14. pH 7.0 is the neutral point, from 7.0 to 1.0 denotes increasing acidity, from 7.0 to 14.0 increasing alkalinity.

Phytocide. Pesticide compound toxic or injurious to plants in leaf when applied at normally recommended dosages.

Phytotoxic. Capacity to induce injury, stunting or reduction in yield of plants.

Post-emergence treatment. Application of herbicide to crop after seedlings have emerged from soil and are growing.

Pre-emergence treatment. Application of herbicide to soil at time of planting seeds or afterwards, but before seedlings have emerged.

Pre-planting treatment. Application of herbicide to soil before crop is planted.

Repellants. Pesticides or other materials which repel or drive away a pest due to unliked odour, colour, taste or mechanical effect.

Residual sprays. Sprays of pesticides which form a fine deposit on exposed surfaces after settling from air.

Slurry. Thick suspension of pesticide used in treating seeds, or a paste-like preparation resulting from mixing pesticide with water.

Solution. A homogeneous mixture of a solid, liquid or gas with another liquid termed the solvent.

Solvent. The medium within which a substance is dissolved, *e.g.* aromatic petroleum derivative solvents for DDT etc.

Space spray. Pesticide spray capable of filling air within a given area with suspended droplets which collect on insects flying or passing through treated space.

Spray residue. Fine deposit remaining after application of pesticide spray which retains active pesticidal properties against pests resting on or crawling over treated surface.

Stomach poison. A pesticide material eaten, lapped up or swallowed by an insect and absorbed through its stomach.

Surfactant. A material which, when used in a pesticidal formulation, imparts emulsifiability, spreading, wetting, dispersibility or other surface-modifying properties.

Suspension. Particles of a pesticide dispersed and suspended in liquids, such as water and oils, *e.g.* wettable powders.

Systemic. Term applied to pesticide applied to soil or foliage, absorbed by plant parts, translocated to other parts of organism and imparting protection from insect or disease attacks; the action of an herbicide in affecting the entire plant, resulting in death; action of plant disease in which single infection results in spread of pathogen throughout the organism.

Toxic. Poisonous.

Toxicant. Term frequently used to designate the preferable term ' active ingredient '.

Toxicity, acute. That which is manifest on short exposure, such as a single oral intake of a pesticide.

Toxicity, chronic. That which is manifest when toxicants act upon the body over a long period of time, such as daily exposures.

Toxicity, oral. A poison reaction resulting from oral intake of pesticide.

Weed. Any plant which grows where not wanted.

Weed, annual. Plant that naturally completes its life cycle within one year from germination to seed production and death.

Weeds, perennial. Herbaceous plants that live for more than two years, *e.g.* trees and shrubs. Those living only for two years are called biennials.

Wettable powder. A pesticidal formulation manufactured by milling a pesticide, an inert diluent and a wetting agent to a fine powder which is easily wetted by water and will go into a semi-permanent suspension.

Source: *Agricultural Pesticide Guide Book.* Pub. by Diamond Alkali Company. New York. 1959.

Insects and Stored Food

1—World Losses

E. A. PARKIN,* D.SC., D.I.C., M.I.BIOL.

Increasing population and rising living standards make imperative the elimination of losses caused by insects. In this article the extent of world losses is reviewed, control measures outlined and sources given from which advice may be obtained.

THE need for a considerable increase in food production is fairly obvious, and those who concern themselves with the future problems of existence on this earth are well aware of it, but the need to conserve what has been produced and to minimise deterioration of crops between harvest and consumption is only slowly gaining recognition.

Caterpillars leaving the sacks in the autumn. They spin cocoons and hibernate in crevices in the walls and ceiling

Stored products

Foodstuffs may be broadly divided into perishable and non-perishable, the former generally requiring special handling, marketing and transport to distribute them to the consumer whilst they are still fresh. The non-perishable foodstuffs, on the other hand, can be stored for considerable periods and include such things as apples, potatoes and ' stored food products '.

The last named may be distinguished from the other groups by having a moisture content of some 20% or less, which makes possible storage periods of up to several years. The commonest form of deterioration among the group of products with a moisture content above 20% involves fungal infection, whereas the group with the lower moisture content suffers mainly from insect infestation.

The most important groups of stored food products are the raw and processed forms of cereals, pulses, oilseeds, dried fruits and nuts, spices, cocoa, coffee, tea etc., together with some animal products.

It must be emphasised here that the

Photos: Published by permission of the controller H.M.S.O. From Min. of Agriculture leaflet 'Warehouse Moth'

Cocoa beans badly damaged by caterpillars of the warehouse moth. Note the piles of excrement on the beans

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stored-product entomologist is concerned as much with the processed products and their stages of manufacture as with the raw materials, and his interest is, therefore, extended to problems of insect infestation during and after processing. In consequence, his background knowledge must cover post-harvest processing and storage, and he concerns himself little with agricultural problems, except where a product may be infested before harvest by insects which can continue their depredations in the store after harvest. Moreover, stored products form an important part of international trade and problems of spread or increase of infestation during transport loom large.

Stored - product entomology may therefore be regarded, not as an extension of agricultural entomology, but as a subject in its own right which concerns itself with all aspects of insect infestation in all the ramifications of storage, transport, processing and marketing of the appropriate crops.

Extent of losses

An estimate of total losses is extraordinarily difficult to obtain, but a meeting of experts, under the auspices of FAO,[1] concluded that an average loss of 5% of the world's production of harvested foodstuffs was a conservative figure. This means that, taking the present world population as 2,600 million, enough food is being lost to insects to feed another 130 million people at the average subsistence level and at no additional cost because the labour and outlay involved in growing this food have already been expended. This figure of 130 million may be doubled if account is taken of the additional depredations by rodents, similarly estimated as accounting for 5% loss.

Because the activity and rates of increase of insects are largely conditioned by temperature, infestation of stored produce will naturally be greater in warm climates than in temperate. Losses of 25% or more of edible material are common in the tropics during a few months of storage, although the true extent of loss is all too often obscured by the retention in the raw product of large quantities of insect remains and excrement. A side-effect of the large number of individual grains and seeds that may be damaged when infestation is severe is interference with the germinative power of seed stocks and consequent reduction in the next harvest.

Many examples of losses and damage by insects to stored crops have been cited by the author elsewhere,[2] but two more recently published estimates may be mentioned to give an idea of the magnitude of the figures involved in tropical and sub-tropical countries.

D. Barnes[3] has reported that losses of maize through insect damage after harvest in Mexico have been put at 15–25%, although he thinks this is on the high side. Nevertheless, even if the losses were as low as 5%, the 1954 maize crop would have suffered a depreciation of 225,000 tons, valued at about 10 million U.S. dollars.

In Kenya careful assessment by S. Kockum[4] led him to estimate the average loss in 1952 of crib-stored maize as 9.6% of the weight in four months, rising to 23.1% in six months. In the untreated part of an experimental crib of cob maize there was an increase in the number of damaged grains from 1.12% at the start to 91% after 10 months' storage. The application of insecticidal treatment since 1953 to some 10% of the crop has resulted in a presumed saving of about 15% in weight, which, in turn, is interpreted by Kockum as an annual gain to the farmers of around £300,000; there is also the corresponding increase in available foodstuff.

Losses in the temperate zone are generally much smaller, but heavy losses do occur occasionally. One must always bear in mind that losses are not by any means directly related to the amount of product eaten by the insects.

Æsthetic feelings, which become more potent the higher the standard of living, can well lead to condemnation of foodstuffs which are seen to contain insects or to show signs of insect activity, such as webbing, even though an insignificant portion of the foodstuff has actually been consumed by the pests. Indeed, instances are known when costly measures have been necessary to process foodstuffs for the removal of insects that did not attack the food, but found their way into it from another heavily infested product.

As has been discussed in detail by Freeman,[5] the losses caused by insects to stored foodstuffs can be suffered at all stages of storage and handling and can be very complex. Moreover, some forms of loss are not really assessable in terms of money.

For instance, if a manufacturer were so unwise as regularly to supply infested produce he would rapidly lose the goodwill of his customers with devastating effects on his business, but unless he were the sole manufacturer of the product his loss of trade would be his competitors' gain, and the effect on the industry as a whole would be nil. So long as there is a potential threat of loss of goodwill, however, the manufacturer will have to take control measures against insect infestation, and the cost of these measures must rank as a financial loss attributable to the insects. Even the cost of sweeping and cleaning must be counted as losses so long as neglect of these precautions leads to an increase of insect infestation.

Extent of infestation

In the U.K. the mill moth and the biscuit beetle are common and troublesome in retailers' and wholesalers' stores. In factories the commonest pests are the mill moth, warehouse moth and flour beetles.

The moths are particularly troublesome because not only do their caterpillars spin webbing which may block chutes and cause expensive shut-downs for cleaning, but the adults can fly, and therefore infest foodstuffs in factories and mills at any time from the intake of raw material to the despatch of the finished product.

Since minute quantities of infestable debris can satisfy insects throughout their whole existence, from the egg to the adult, insects brought in with raw materials may breed in the dust of produce that settles on beams and in odd corners. It is in such places that the endemic infestations are maintained, and failure to appreciate this is presumably largely responsible for lack in improvement in design of factory and mill machinery to obviate these weak spots.

At various times in its history produce is subject to some risk of cross-infestation during transport, and frequent cleaning of lorries and wagons is necessary to avoid accumulations of spillage in which insects may breed; food residues pressed into crevices between floor boards are a weak spot here. Opportunities for cross-infestation are also good in port warehouses. Many products move fairly rapidly through such warehouses, but others stay for long periods for lack of other storage

space and are then subject to attack, not only by cross-infestation, but also by the endemic infestation of beetles, and especially moths, that seem to be so well able to maintain themselves in these storage premises over the years.

Much stored food in the U.K. is imported and a significant amount arrives in an infested condition, either because the foodstuffs were exported infested or became so by cross-infestation during the voyage. Zacher[6] has pointed out that in 1954 four million tons of grain were imported into Germany, of which he estimates that 40–60% was infested by beetles and that some 2,000 million beetles were thus imported.

Insects are particularly active in warm environments and the combination of tropical temperatures during loading and the sustained heat in some holds close to the boilers encourages multiplication and spread. In the tropics insects are often so numerous and their activity so great that it is extremely difficult to organise and apply effective control measures to prevent infestation.

Moreover, up to the present there have been too few workers to investigate properly the possibilities of control and the best ways of making use of the existing methods. However, advance has been made here and there, showing that, with skill and patience on the part of research workers and sympathetic backing by official and commercial trade and export organisations, the level of infestation in exported produce can be markedly lowered.

Any progress will, however, be welcomed by the importer, since it helps to lighten the burden of risk of infestation that he now has to carry, including the risk of having to treat the goods before sale or processing.

The import of infested goods is a problem important to traders and manufacturers who may re-export to another country where standards of food hygiene are rigidly enforced and may lead to the rejection of a parcel on arrival. Fortunately, this has not happened often, but the risk is always present and cannot be overlooked.

(To be continued)

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The Machine in Tropical Agriculture

3—Employment and the Machine

RAY WIJEWARDENE, B.A.(MECH.SC.), M.A., A.M.I.B.A.E., M.A.S.A.E.

In the previous articles the author discussed the uses and limitations of agricultural machines in tropical agriculture. Here he explains how the machine has reduced the man-power requirements of the rice crop – with special reference to Japan.

POPULATION-LAND ratio is a factor which has never been given adequate consideration when tropical power farming problems have been discussed. It is pertinent, particularly when experts from abroad talk airily about opening the paddy lands into 'large fields instead of the present blocks of postage stamp size'. There is a definite reason for these small fields, and every possibility of them becoming smaller, as has happened in Japan.

Most countries of the West and in the temperate regions have a low population-land ratio, exceptionally so in comparison with tropical countries, where there is a likelihood of it increasing rapidly with the years. The position of most tropical countries is likely very soon to become similar to that which Japan is now facing. The Japanese, being a predominantly rice-eating nation, have developed a line of agricultural machinery which is perhaps better suited to small-scale agriculture in the tropics than the tractor mechanisation developed in the West.

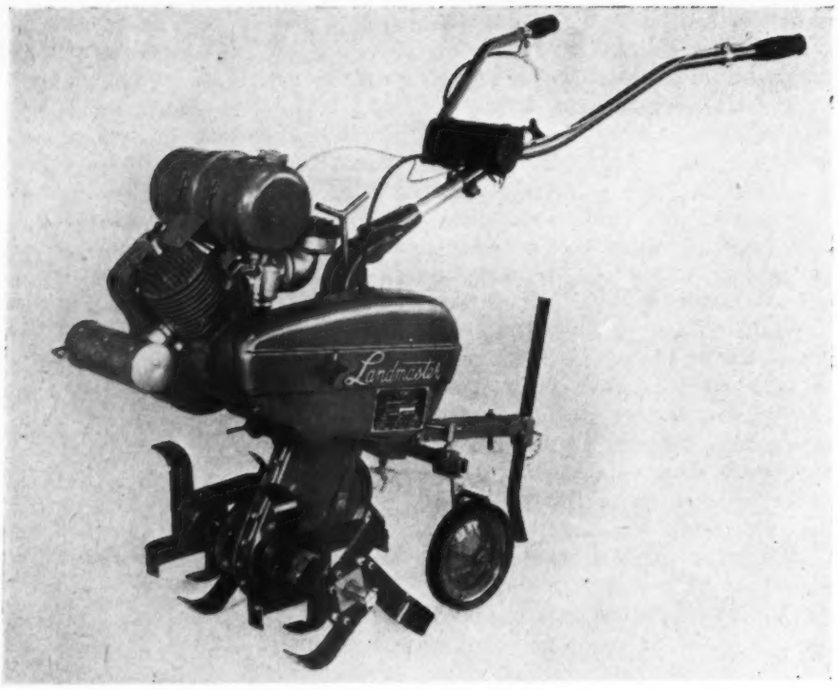
Too little land

The problem of too large a population and too little land is a serious one, which is aggravated in countries with industrialisation levels too low to absorb those crowded off the land. Even in a highly industrialised country like Japan this problem became so acute that the MacArthur government saw fit to take over all agricultural lands and redistribute them – not in large units, which to the Westerner would appear more economic – but in smaller units, each farmer having only between ½ and 1½ acres, according to the size of his family.

Japanese farming is particularly interesting from the aspect of the man-power requirements per crop, which, though high, is necessarily so. Japan is mechanising, slowly but surely, and for the interesting reason that, since

Photo: FAO

Rice is the basic food of more than half of the world's people. Here a girl is seen cutting off the heads of paddy, using a tupai *or hand cutter*



A governor-controlled 4-h.p. rotary cultivator with 2-speed transmission

the income from farming of such small acreages is far below that needed to keep a family at even a subsistence level, the Japanese farmer must turn to industries – both cottage and large-scale – to supplement his income.

The machine thus serves to reduce to the barest minimum the time which the farmer need spend on his land and thus give him more time for alternative employment.

Rice cultivation, too, has periods of peak labour requirement and it is in the reduction of these that the machine can best serve tropical farmers, for it enables one man to farm either a larger acreage by himself than the 2 to 4 acres to which he is restricted when using animal draft, or a smaller acreage in less time, thus enabling him to supplement his income by other work.

Small-scale mechanised farming

The farming of small acreages is well known in the West as market gardening and it is therefore not surprising that when the Japanese turns to power he uses the market-garden tiller as the machine for his market-garden size plot. It was only comparatively recently that the roto-tiller idea came into usage in Japan and it has swept the market like wildfire.

It is simple, hardly anything more than an engine on a frame, with single belt drive to a totally enclosed transmission or chain case and thence to the wheels or rotors. It is cheap, barely one-eighth of the price of a tractor, and economical, cultivating about an acre a day on 2 gal. of petrol. Its rotary tiller operates at relatively low speeds of 60–90 r.p.m., thus cultivating with a gentle finger-like stirring action.

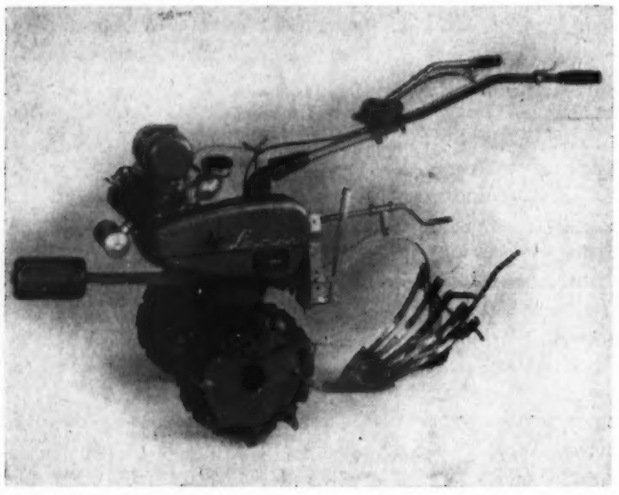
Moreover, it can draw a trailer with a load of about a ton and is amazingly versatile. For it can plough, harrow, roto-till, seed in rows, irrigate, inter-cultivate, ridge, spray and harvest a variety of crops, including paddy (rice) and is probably the only machine yet known which will cultivate, puddle and level the muddiest paddy field in the 'D' type of the soil catena,* in all weather conditions, without any tendency to bog in.

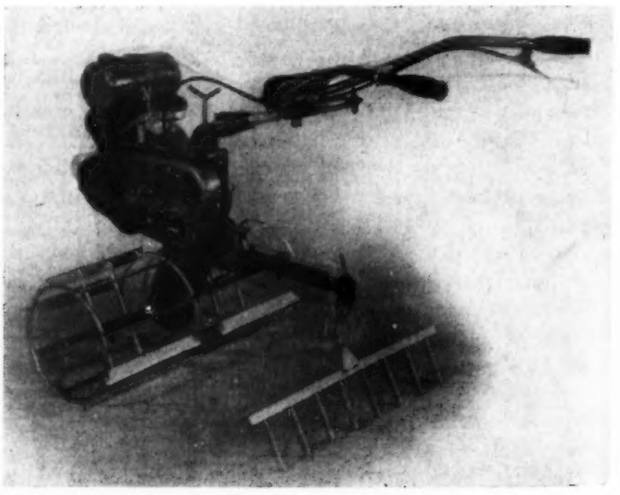
It is also possible that being so light and tiny, and yet so sturdy and manoeuvrable, it will also be able to operate in the 'A' types for the inter-cultivation of tea and rubber on slopes otherwise inaccessible for machinery.

Certain small adaptations will, of course, be necessary to this machine – modifications such as lower handle-bars to suit the smaller stature of the tropical farmer, better axle oil seals to prevent the entry of mud and silt into the transmission case, and convenient adaptors to take locally-made implements and for the special requirements of certain crops.

* Catena: series – see Part 1.

(To be continued)





Left: *reversible plough attachment, complete with paddle wheels and counter-weight.* Right: *special attachments for puddling the paddy fields after they have been irrigated*

New Publications

Pests and Diseases

The Control of Pests and Diseases in Agricultural and Horticultural Crops. By G. L. Hey, M.A., and K. Marshall. Pp. 120. Illustrated. London: Vinton & Co. 1958. 12*s.* 6*d.*

Since the discovery of the insecticidal properties of DDT and the gamma isomer of BHC there have been remarkable and rapid developments in the use of synthetic insecticides and fungicides on crop plants, the advance of knowledge in the realm of insecticides having been even more rapid and spectacular than in that of fungicides.

There are so many crop protection chemicals now available that the choice of the right one or right ones to use in a particular instance can be most bewildering. In this book the authors tell the farmer or grower why crop protection chemicals should be used and give him the necessary guidance by the concise and clear manner in which the numerous chemicals are grouped in relation to the particular pests or diseases they control.

The authors discuss at some length the immensity of world crop losses due to pests and diseases and their significance with regard to the nourishment and other vital needs of an ever-growing population.

This is followed by a chapter on pest and disease control by cultural, mechanical and biological methods prior to a general discussion of pest and disease control by chemicals. Detailed descriptions of the more important insecticides, fungicides and seed dressings follow.

There are chapters on the pests and diseases affecting farm and market crops, pests and diseases of fruit and hops, and pests and diseases of glasshouse crops and mushrooms.

There are brief accounts of the life histories of many pests and causal organisms of diseases to explain the reasons why control measures are applied at certain specific times. Full consideration also is given to the methods of application of crop protection chemicals, including detailed descriptions of high- and low-volume sprayers and of dusting machines.

The book has a useful glossary of popular names of pests and diseases with their corresponding latin names, and there is a list of recommended reference books, in addition to other references to literature in the form of footnotes in the text.

E. F. S. SHEPHERD

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The Biology of Mycorrhiza

By J. L. Harley. Pp. 233. Illus. Plant Science Monographs, London. Leonard Hill Ltd. 1959. Price 55*s.*

The normal root environment is the soil, and plants share this environment with a great variety of micro-organisms with some of which they may enter into highly specialised associations.

Mycorrhiza, which are dual organs composed of fungal hyphae and plant roots, are an example of such association. They vary considerably in structural detail and in the identity of the fungal component, but particular plant species characteristically develop their special type of mycorrhizal association. In forest trees, which are usually grown on soils of low nutrient availability, the ectotrophic mycorrhizal condition is the normal state of the absorbing roots.

Dr. Harley reviews the experimental evidence concerning the metabolism of these roots and their fungal components and concludes that the most clearly demonstrated function of the mycorrhizal root is the increased absorption of nutrients, particularly phosphorus, into the fungal sheath and its subsequent release into the plant under conditions of adequate aeration.

Less is known about the mechanism whereby mycorrhizal fungi stimulate the germination of orchid seeds, though it is evident that in some saprophytic species the carbohydrate nutrition of the plant is to some extent dependent on the fungal symbiont. The biological significance of the endotrophic mycorrhiza, which are very widespread in many crop plants of economic importance, *e.g.* wheat, grasses, temperate fruit trees and citrus, is almost completely unknown, although recent advances in the synthesis of these mycorrhiza have brought experimental work within reach.

All interested in this field will be grateful to Dr. Harley for his reasoned approach to the subject, which has suffered from too much conjecture and controversy in the past. In particular, the approach of the ecologist who views the mycorrhizal association as only one of many associative phenomena ranging from the casual and non-specific colonisation of root surfaces to highly specialised pathogenic infections of the vascular tissue is of value. While the book is intended mainly for the specialist, its clear arrangement and sectional summaries will be helpful to the more casual reader.

B. MOSSE

Modern Humus Farming

By Friend Sykes. Pp. 262, 25 illus., two maps. Faber and Faber, London. 1959. Price 28*s.*

'Will there be a second Black Death?' asks Friend Sykes in his latest version of 'Humus – and the Farmer'. Maybe there will if the present rate of increase in world population continues, perhaps at an even greater rate, due to the wider application of the amazing results of modern medical science, for each day that passes now adds to an ill-fed world another 100,000 mouths.

To meet this situation farmers have been driven to the increased use of chemical fertilisers and of protective chemical sprays and dusts in order to increase the productivity of the existing acreage under food crops, prevent local famines, and keep down the price of food so that no one need starve. In this struggle for human existence we are fighting a losing battle, for between two-thirds and three-quarters of mankind are still undernourished.

There are some who optimistically speak of miracles, of the possibility of feeding the world on harvests of sea food to be collected from the depths of the ocean, on water-weed, on grass

extracts and on synthetic foods produced by combining carbon, hydrogen, oxygen, nitrogen and the vital trace elements.

Friend Sykes, who describes himself as a compost farmer, condemns heavy applications of artificials, which make 'rank and poor-quality crops jump out of the ground', and he poses the very real threat to crops, man and beast from the widespread use of poison sprays, hormones, antibiotics and factory-made concentrates; he emphasises that much cattle disease is also due to deficient herbage. He states that: 'the source of *all* disease is in the quality of food we eat; and the food comes from the soil. Start there. Make a healthy living soil. Grow thereon a healthy plant. Produce a healthy animal and, in turn, a healthy man, and the Ministry of Health can be liquidated eventually' (p. 60). 'Why cannot we adopt my system tomorrow and in *five years* have a *disease-free world*?' he asks.

I have a certain sympathy with what the author writes, for I was Camp Compost Officer at Changi, where the diet consisted principally of polished rice, tapioca root, 'greens' produced from a tropical weed of the *Amaranthus* spp., grass juice produced from lallang, *Imperata cylindrica*, poonac, crude seawater salt and about 1 oz. of dried fish a day. In those three and a half years compost preserved the life and the health of thousands by progressively increasing the productivity of our gardens.

With dwindling supplies of rice, the secret of survival lay in the increased production of tapioca root and amaranth leaves, the stalk of which was served as asparagus. In the 'lifeless' sandy soils of the Changi district this necessitated building up soil fertility by heavy applications of compost.

This was produced at five depots, where grass and kitchen waste, urine and wood ashes were the raw materials and a jacket of grass was used to keep in the heat and keep out the flies, and so prevent the spread of contagious diseases – cholera, dysentery and typhoid. Two facts emerged: compost making was very heavy work, due to the fibrous nature of the raw material; and the increased production was obtained by concentrating the fertility of 10 acres on to one acre by collecting grass from the surrounding countryside for composting.

Thus Friend Sykes is both right and wrong; his case suffers from the exaggerated claims that he makes. Obviously the whole world could not, and would not, adopt his system; many of his claims are not, and cannot, be substantiated. He makes great play of the fact that he is a breeder of winning racehorses, fed on humus-grown herbage, but in the absence of 'controls' such evidence is valueless. One might equally well point to the 4-min. milers who have been raised on artificially-produced foods.

To sum up, the book is challenging, provocative and highly controversial. What Sykes says not only needs to be said, but also to be read by every specialist and to be hotly debated among laymen. There are two very useful chapters for the agricultural engineer: chapter X, on the subject of deep cultivation by subsoiling; and chapter XI, dealing with the question of deep *v.* shallow ploughing.

F. C. COOKE

Agricultural Aviation

This quarterly publication of the European Agricultural Aviation Centre is a source of up-to-date information on agricultural aviation developments, not limited to the continent of Europe, although published there.

The first issue contained articles on aerial spraying in England and forest spraying operations in Germany.

The subscription is 24*s.*; F. Frs. 1,700; U.S. $3.50 or equivalent. Obtainable from le v.d. Boschstraat 4, The Hague, Netherlands.

Farm and Food Pests

Infestation Control. A Service to Agriculture and Food Storage. Pp. 32. Illus. Obtainable from H.M.S.O., Kingsway, London, W.C.2. Price 4*s.*

Farmers, seed merchants, millers and many others connected with agriculture and the food trade who are aware of the widespread damage done by insects and other pests to stored products and by harmful mammals and birds to growing crops will welcome this new publication, which gives an account of the scientific work undertaken by the Infestation Control Division of the Ministry of Agriculture in the field of research into ways and means of controlling these pests.

This attractive and well-illustrated booklet describes fumigation and other modern methods of dealing with stored-products insects, new methods for controlling rats and mice, the measures now in operation for the control of land pests – with particular reference to the rabbit – harmful birds, and the history of pest control during the last 45 years.

A brief outline of the Ministry's Regional Service with a map showing the present regional boundaries is included. A reference list of scientific papers published during the past 16 years by the staff of the Infestation Control Division provides a useful guide to the scope of this important aspect of the Ministry's work.

Cordage Fibres

The Technology of Cordage Fibres and Rope. By David Himmelfarb, B.S., M.S. Pp. 370. Illustrated. Leonard Hill (Books) Ltd. 1957. 35*s.*

This must surely be the most comprehensive – and certainly the most up-to-date – textbook on rope-making yet produced. It describes in detail every cordage fibre known today – its classification, use, structure, properties etc. Preparation of the fibre, spinning of the yarn, twisting, laying, braiding and finishing operations are all dealt with in a thorough manner. Quality control, production analysis and environmental protection are covered, while the last 50 pages of the book constitute a glossary of the multifarious uses of rope, cordage and twine.

Pests on Stored Grain

A monograph entitled 'Insect Pests in Stored Cereals'. Published by Munton & Fison Ltd., Stowmarket, Suffolk, England. Available on application.

There are 150 known pests of grain and cereal products; the brochure describes in detail the 13 worst offenders, their life stories and bad habits. It gives 36 practical 'do's and don'ts' for their effective control and describes the physical and chemical methods of ridding storage installations of infestations.

With the increase in combine harvesting and of the storage of grain on farms, the risk of pest infestation becomes potentially more serious and prevention in the early stages is better than cure when a serious outbreak occurs. This brochure will therefore be of practical value to cereal farmers and seed merchants.

The De Havilland 82A Tiger Moth (Agricultural Aviation Co. Ltd.) taking in supplies from a Berk 'Airspray' tanker, which served as its mobile operational base at the demonstration

Demonstration of Agricultural Aircraft

Following the recent Agricultural Aviation Conference, organised by the European Agricultural Aviation Centre, at Cranfield, England, there was a display of spraying and dusting by helicopters and fixed-wing aircraft, some of them operated from mobile operational bases.

The following is an account of companies which participated in this demonstration.

A D.H. 82A Tiger Moth converted for agricultural duties by the *Agricultural Aviation Co.* was shown at the display. The boom is of corrosion-resistant mild steel tube of streamlined section and 34 nozzles are fitted along the 30-ft. span. Attached to the wing by tear-away links, the boom will fold back without damaging the aircraft should they foul an object during the spray run.

Liquid is fed from the aircraft hopper, fitted in front of the pilot, into the boom through a windmill-driven centrifugal pump. This unit is capable of delivering up to 12 gal. per acre at high pressure. Its normal output is $3\frac{1}{2}$ gal. per acre.

The position of the boom is such that it is possible to spray successfully and without appreciable drift in winds up to 20 knots. Droplet size may be varied from 80 to 300μ in diameter, thus giving effective cover without the drift hazard associated with smaller droplets. A special feature is the hopper dump-valve, by which, in an emergency, the pilot can jettison the entire contents in only two seconds.

An agricultural aircraft tender, designed and constructed on a 5-ton Bedford chassis by *F. W. Berk & Co. Ltd.*, fulfils the three essential roles of tanker, chemical transporter and mobile operational base.

Forward are three tanks – for water, chemical mixing and aviation spirit – whilst the rear space can be taken up by approximately one ton of chemicals in containers. Requisites such as heavy-duty scales, pumps, hoses, shovels etc. are located at accessible points and the installation of a flashing marker beacon inset in the cab roof, a wind sock mounted on a telescopic mast and radio telecommunication contribute to the vehicle's requirements as an operational base.

Airspray (Colchester) Ltd. used the Jackaroo crop sprayer. This is a development from the Tiger Moth. A 60-gal. spray tank is fitted in place of the two right-hand seats of a standard Jackaroo. The pilot in the left-hand front seat has an excellent view and a marker or mechanic can be carried in the rear seat between operating areas.

A Stuart-Turner centrifugal pump drives spray fluid from the tank to two under-wing, Allmann 15-ft. booms equipped with 15 Allman nozzles. If atomisers are used, these nozzles can be blanked off in a few minutes and the atomisers connected to the spray booms instead; thus only external piping is used, eliminating the possibility of internal leaks in the wings or the need to open up the fabric. It can be converted back for use as a boom sprayer in an equally short time.

Crop Culture (Aerial) Ltd. is one of the larger aerial operating companies, with a fleet of over 40 aircraft, including Tiger Moths, Auster JINs, Workmasters and Piper PA-18-As. In the U.K. the company's Tiger Moths are equipped for both spraying and top-dressing with solid fertilisers. They have treated a wide range of crops from orchards and hops to potatoes and peas, working in most regions of the country.

The Kolibrie, which was the first helicopter designed chiefly for agricultural use, is distributed by *European Helicopters Ltd.* The technical advantages of using the ram-jet as a source of power are numerous, but one most important point is its simplicity and economy in maintenance. The

Photo: Farmer and Stockbreeder

Low flying and spraying by the Prospector (Lancashire Aircraft Co. Ltd.)

Kolibrie, with its very large swath width – 66 ft. – and remarkable manoeuvrability, can with great accuracy spray upwards of 75 acres per hour.

Farmair Ltd. has had considerable experience of aerial application of sprays and top-dressings in the U.S.A. Using a Piper PA-18-A, which has been proved in the U.S.A. for agricultural purposes, the firm offers a complete and efficient service to British farmers. The PA-18-A, powered by a 150-h.p. Lycoming engine, has a gross weight of 2,090 lb., a load of 1,010 lb. and a hopper capacity of 18 cu. ft.

Fison-Airwork were demonstrating two Hiller C helicopters, ideal for U.K. field conditions where there are invariably obstructions, such as trees, hedges and telegraph poles, which it can skirt and avoid with greater ease than a fixed-wing aircraft. This helicopter is able to turn sharply at the end of each spraying run and therefore cuts waste flying time. In helicopter spraying, the downwash from the rotor blades forces the spray directly on to the crop itself and thus minimises the risk of drift on to adjacent crops.

This company also showed the Auster J1B at Cranfield to demonstrate their rotary-driven fertiliser distributor. Fed from a 4-cwt. hopper mounted behind the pilot's seat and operated by a wind-driven fan which actuates rotating vanes, this fertiliser spreader has many advantages over earlier types. It can cover a 100-ft. swath at 65 m.p.h. from a height of 20 ft., and the pilot-controlled regulator valve in the cockpit achieves an accurate and evenly distributed spread.

Helicopter Services Ltd. has developed its flying technique, after exhaustive tests carried out in conjunction with *Plant Protection Ltd.* during the years 1956–57, with the object of producing a satisfactory cover using a low-volume application. This has been used commercially on a variety of crops and a big volume of acres. The crops include potatoes for blight, sugar-beet for the aphid, and vegetable crops for various insect pests. During 1957 and 1958 the company also undertook experimental treatment of bracken with successful results. In normal conditions the Bell 47.9 helicopters used are capable of giving a satisfactory coverage to some 60 to 80 acres of crops in a flying hour.

Lincs Aerial Spraying Co. have had nine years' experience in the aerial application of sprays and top-dressings, using specially adapted Auster aircraft. The spraying and top-dressing equipment used ensures a full and even distribution of materials and the entire mechanism is under full view and control of the pilot.

The Workmaster, the latest *Auster* agricultural aircraft, is a combined duster-sprayer. The 180-h.p. Lycoming motor gives increased safety margins in all conditions of flight. An 80-m.p.h. operational speed gives a 25% speed advantage and other features of note are the double-thickness windscreen and the low-pressure oversize tyres, the latter enabling continuous operations from rough or soft airstrips. The orthodox spray bar may be replaced by four rotary atomisers should this be desired. For dusting operations a spreader unit is fitted to the underside of the aircraft.

The *Auster* Agricola was one of the first aircraft in the world to be specifically designed for aerial farming duties. It combines high performance with high load capabilities and exceptional measures for pilot safety. New corrosion-resisting points and dust-proof sealed-in airframe units provide a prolonged operational life. The Agricola is suitable for all agricultural work, including spraying, dusting, fence and supplies dropping, aerial baiting and light freighting.

The D.H.A.2 Beaver is a general transport bush aircraft produced by *De Havilland Aircraft of Canada Ltd.* and used in a number of countries in agricultural duties. With a standard tankage of 200 gal., the Beaver has one of the highest work outputs. The Pratt and Whitney 450-h.p. Wasp is its standard power plant. The machine was shown at Cranfield with Britten-Norman 'Spraypack', a self-contained spray unit, one of which is mounted under each wing, containing its own pump and 'Micronair' spray gear and holding 75 gal. of chemical. This particular unit was designed for locust work.

Formerly the Edgar Percival E.P.9, the Prospector has been designed specifically for agricultural spraying, dusting and seeding and was demonstrated by the *Lancashire Aircraft Co. Ltd.* With its short take-off and landing ability, economy and ease of maintenance this machine is suitable for bush operations. For operational economy in the off-season the design was made quickly adaptable to other roles; these include six-seat transport, aerial survey and supply dropping,

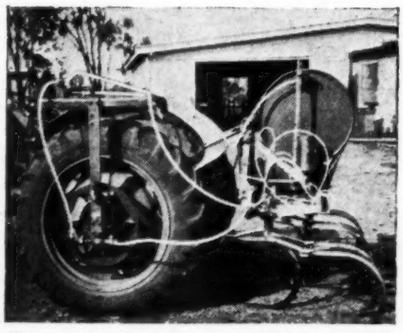
whilst the rear door and roomy cabin allow easy loading.

The L-60 Brigadyr by *Omnipol of Prague* is a general-purpose high-wing aircraft of robust construction powered by a 220-h.p. Praga Doris 'flat' 6-cylinder engine driving a variable-pitch propeller. The aircraft is specially designed for safe operation from short improvised airstrips. It is fitted with a long-travel undercarriage of great strength and has full-span interconnected slots and flaps which provide very low minimum speed and short take-off and landing runs. The agricultural version is intended for liquid or powder spraying and has a hopper of 69 gal. capacity installed in the fuselage. The spraying equipment is operated by engine-driven pumps and can discharge up to 660 lb. of powder or 66 gal. of liquid per hour. The change over from one type of spraying equipment to another is quick and easy. The aircraft can spray a strip 65 ft. wide at a speed of 65–75 m.p.h. and has a maximum endurance of four hours.

The *Piper* Pawnee demonstrated by *Vigors Aviation Ltd.* is a new aeroplane designed for the sole purpose of applying agricultural chemicals for crop improvement and insect control. It is a low-wing monoplane with design features which ensure pilot safety and the maximum efficieny. Powered by a 150-h.p. Lycoming engine, the Pawnee has a gross weight of 2,300 lb., a useful load of 1,100 lb. and a hopper capacity of 110 gal. or 120 cu. ft. The Pawnee has been designed for operation from short, rough fields close to the operating area.

The new *Hiller* UH 12-E three-place helicopter, powered by the 310-h.p. Lycoming VO-540-A1A engine, cruises comfortably at 90 m.p.h. At its maximum gross weight of 2,700 lb. its hover ceilings I.G.E. (in ground effect) are 9,500 ft. and 6,000 ft. respectively. Thoroughly tested in tropical conditions of high temperature and high humidity, *e.g.* at 10,000 ft. with temperature at 130°F, the 12-E will hover with a useful load of 800 lb.

Machinery and Equipment



Tractor fitted with 'Nema-Jet' pressure-injection equipment. Note adjustable pressure pump fitted on wheel

War on Nematodes

The 'Nema-Jet' pressure-injection unit was designed by the *J.S. Engineering Co. Pty. Ltd.* to ensure that the correct amount of a fumigant is injected into the soil uniformly, irrespective of the speed of the tractor on which it is mounted; in other words, that the dosage remains constant with varying tractor speeds.

The system uses a wheel-mounted pump, which sucks the liquid from the main supply tank and delivers it under pressure through a control valve to a manifold leading to eight jets mounted on the tines of the cultivator. Each line has its own filter to prevent internal blockages and the nozzles will not clog even in the heaviest soil, since they deliver the fluid under pressure. There is a cut-off valve within easy reach of the driver to short-circuit the fluid back to the supply tank when the tractor is being turned at the end of the row.

This machine is being used exclusively by the South Queensland Tobacco Growers' Co-operative Association, by the Sugar Experiment Station and by pineapple planters and tomato growers in Australia.

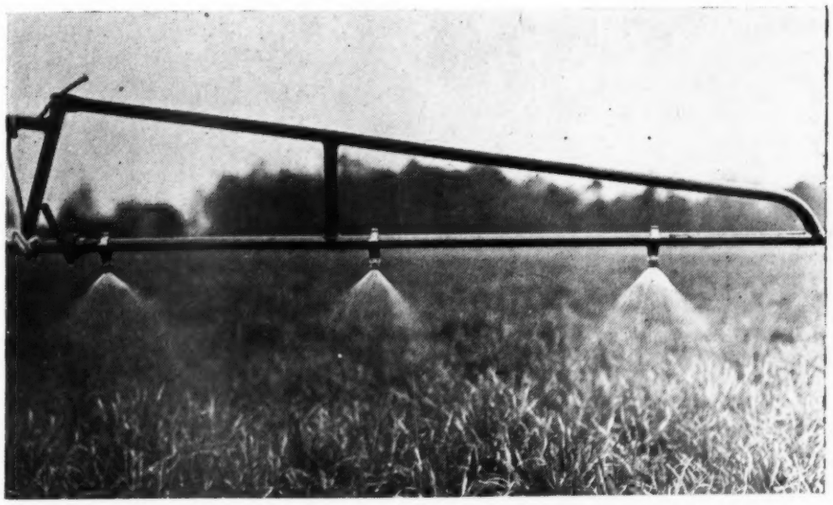
Long-arm Boom

The *Dorman* 100-gal. 'Super' boom sprayer has a 31-ft. 6-in. rear-folding boom and a pump which will deliver 22 gal./min. and give an application rate of 10 gal./acre at 10-lb. pressure. It can be mounted directly on the Universal Fordson Major and Ferguson tractors and can also be fitted to the Nuffield and David Brown tractors with suitable brackets.

Fibreglass Spray Tank

A rust-free fibreglass tank of 200 gal. capacity is offered by the *Oliver Corporation* as a new addition to its sprayer equipment line. Weighing only 70 lb., it is designed for mounting on the Oliver No. 233 trailer field sprayer or for use as a skid-mounted container.

The tank eliminates corrosion problems, such as strainer and nozzle clogging, generally associated with agricultural spraying operations in



A close-up of the Dorman no-drift nozzles fitted to a 31-ft. 6-in. spray boom

The Mapic D5 soil injector, used for nematode control, the application of fertilisers and insecticide fumigants

which metal containers are used, since fibreglass effectively resists most agricultural chemicals, including liquid fertilisers.

Soil Fumigation Under Pressure

The ' Mapic D5 ' soil injector, produced by *Cooper, Pegler & Co. Ltd.*, is a very handy implement for the injection of insecticides, such as chloropicrin, carbon bisulphide etc. into the soil under high pressure. Routine measures for the protection of such crops as pineapples, tobacco, tomatoes, sugar-cane, strawberries, bananas, citrus, passion fruit and gourds against nematodes and the application of fertilisers are both within its capacity.

It is fitted with a ½-gal. capacity plastic container and its powerful pump shoots the chemical into the soil at a pressure of about 425 lb./sq. in. The normal measured dose is 5 c.c., but by adding measuring rings to the pump shaft measured doses of 1, 2, 3, 4 or 5 c.c. can be injected. The normal depth of injection is 6 in.; the overall length of the machine is 3 ft. 4 in. and it weighs only 9 lb.

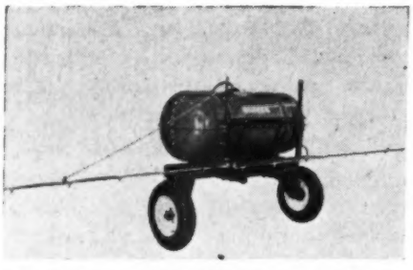
Perfect Bales

International Harvester of Gt. Britain have produced an improved high-capacity pick-up baler – the new model B46.

This machine is more compact than its predecessor and is able to put through a greater volume of hay or straw and to produce uniform and well-shaped bales which are easier to handle and pack much better.

The ' Exact-o-matic ' system employed will make bales from 18 to 42 in. and a new tensioning device will allow them to be made of the required density and up to 70 lb. in weight. This machine can produce up to nine 30-in. bales per minute and collect over 10 tons of hay in an hour. This big output is to be attributed to the new design of feed and the high-speed plunger action giving 75 strokes per minute. Also five rows of pick-up tines now collect the crop instead of the more usual four and the hay is passed into the bale chamber through a larger feed opening.

A big 22-in. flywheel, by its momentum, smooths the flow of power, and it embodies a friction plate and overrunning clutches to guard against overloads, which allows the tractor to stop without clogging the baler. Other features include a convenient weatherproof 4-ball twine compartment, an improved pick-up adjuster lever, and a long adjustable drawbar to give maximum manoeuvrability with a variety of vertical hitch and power drive positions.



The Oliver trailer field sprayer fitted with the new fibreglass tank

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WORLD CROPS,
Leonard Hill House,
Eden Street, London, N.W.1,
England

This drawbar swings to permit the baler to follow directly behind the tractor and, as it is only 8 ft. 2 in. wide, this is convenient for passing through gateways and narrow country lanes, while the overall length of 15 ft. 6 in. makes for easier backing and turning in yards and into farm buildings.

Silage Temperatures

In our September issue the long-stem bimetallic thermometer for taking the temperature of silage, hay, grain, compost, potato clamps and mushroom beds, offered by *Benedict (Agricultural) Ltd.*, was incorrectly stated to be 14 in. long; actually the length of the stem is 40 in.

The driver is able to watch the entire operation of the new McCormick International B46 pick-up baler, including the formation of the bale in the chamber

Agricultural Aviation Exhibition

The following is an account of the participants in the Exhibition held in connection with the First Agricultural Aviation Conference:

The *Britten-Norman* 'Micronair' rotary atomiser is a low-volume spraying apparatus designed specifically for aircraft use. It has been supplied to operators in many different parts of the world and is fitted to such well-known types of agricultural aircraft as the Piper PA-18-A, Auster Variants, Tiger Moth and Beaver. Using the 'Micronair', operators can select the optimum size of droplet for the treatment in hand, ranging from trees and orchards to ground crops. The company also designs spreading equipment for the more even distribution of solid fertilisers.

'Dowpon', the systemic grass weed, reed and bracken killer for aerial application, was the main exhibit on the stand of *Dow Agrochemicals Ltd.* Applied by air, it is the basis of New Zealand's chemical ploughing, which produces new, more productive grass swards without ploughing. Turves shown, resown by this technique, on English and Scottish hill farms, may well revolutionise hill farm livestock production. The stand also showed the results of its use for bracken destruction and for the control of reeds and reedmace in watercourses and drainage channels. For such purposes it is best applied by air.

The Farmers' Co. Ltd. operates an extensive spraying and consultant service, having pioneered efficient aerial spraying and fertiliser top-dressing methods of application by fixed-wing aircraft and jet helicopters over the past four or five years. The company also owns a substantial agricultural seeds business and manufactures granular superphosphates (single and triple) and complete ranges of granular compound fertilisers and animal feeding stuffs.

Fisons Pest Control originated aerial spraying in Britain and has to its credit 11 valuable years of experience with helicopters and fixed-wing aircraft for spraying large acreage crops, as the process is quick and it does not tie up ground machines at a time when they may be urgently required for pest control on other crops. It is claimed that the main advantages of aerial, as opposed to ground spraying, are the speed of application and the elimination of wheel damage. In addition, aircraft are able to operate over wet or waterlogged land when ground machinery cannot be used.

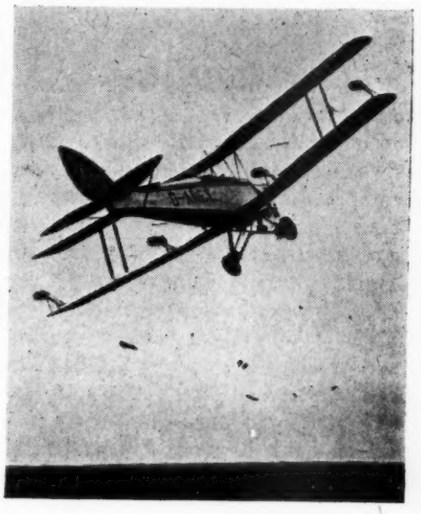

Photo: Farmers Weekly

A De Havilland Tiger Moth (Crop Culture (Aerial) Ltd.) fitted with four Britten-Norman rotary atomisers seen making a turn at the end of its run

Helicopter Services Ltd. exhibited a spray test rig, the boom being half life-size. The two tanks have a capacity of 20 gal. each, capable of covering some 13 acres with an application of 4 gal. to the acre in a run of three minutes. The pilot controls the output of the spray boom by a switch on his control column.

The combined stand of *Plant Protection* and *Imperial Chemical Industries Ltd.* was designed as a meeting place for those engaged in the aerial application of agricultural chemicals. Exhibits dealt with the application of fertilisers and crop protection chemicals from the air; background photographs showed the application of both fertilisers and spray chemicals and also spray patterns of aerial application.

Leek Chemicals Ltd. displayed their well-known range of agricultural and horticultural products (selective weed-killers, insecticides, fungicides etc.) in conjunction with *F. G. Enkel & Co.*, experienced as actual operators and consultants to the trade over the past decade, particularly as pioneers in the

The Packa 'Handipower' knapsack lubricating unit is not only used on farm machinery, but also on agricultural aircraft and helicopters

development of oil-carried concentrates. Together the companies present a range of 'Enkoloid' concentrates, specifically for use in up-to-date concentrate equipment for both aerial and ground application.

The *Murphy Chemical Co.* has made a thorough study of leaf coverage and of pest and disease control using various types of aircraft and spraying equipment and has produced formulations giving correct droplet size for effective coverage of ground crops with 2 gal. or less spray per acre. They offer five products to control potato blight (two in oil for rotary atomisers) and 'DeDeTane 25' (25% DDT) to control common pests of the pea crop.

The *Packer Pressure Equipment Co. Ltd.* showed the 'Packa' portable high-pressure greasing equipment for use on all types of farm machinery and agricultural aircraft.

The pooling of knowledge and resources of *Pan Britannica Industries Ltd.* and *Crop Culture (Aerial) Ltd.* provided the British farmer in the 1959 season with a guaranteed service for spraying and top-dressing from the air. The materials applied included pelleted urea, 'Nitro-Chalk', 'Nitra-Shell', superphosphates, dithane, copper in oil, DDT, malathion, 'Metasystox' and trace elements.

The aeroplane, used as an agricultural implement, has made rapid headway during the past few years, thanks partly to the development of new highly concentrated chemicals and partly to the perfecting of new spraying devices. The *Shell* stand featured chemicals that are available throughout the world for aerial use. Some examples of their application, illustrated on the stand, were insecticides on cotton and rice, fungicides on bananas, insecticides on sugar-beet and top-dressing with nitrogenous fertilisers in the U.K.

Standardised Disinfectants Co. Ltd. has carried out pioneer work on the formulation of specialised products, such as 'Brunokop' copper-in-oil for ultra-low-volume aerial application. This work has been reinforced by collaboration with the French firm of *Schloesing Frères & Cie*, and they are their licensees for manufacture and sale of their fungicide for banana spraying, 'Schlofog C17'. They also manufacture an extensive range of more conventional pesticides for aerial spraying, of which 'Brunozeb DP-65', a zineb-dispersible powder, and 'Malastan 60', an insecticide containing malathion, are notable. 'Hexastan 20' is useful in locust and tsetse fly control because of its high concentration.

Vitax Ltd. are manufacturers of a wide range of pesticides suitable for ground sprayers and aerial application, among which are two relatively new products. 'Weedazol T-L' is a formulation of amino-triazole used for the control of couch grass and a wide range of broad-leaved annual and perennial weeds. A crop can be sown or planted within three weeks of application. 'Weedone Brackontrol', a new formulation for the eradication of bracken, applied at 1½ gal. per acre, will, it is claimed, give 80-90% kill with one application.

Agricultural Chemicals

Holes in Hides

Warble flies of cattle, *Hypoderma bovis* and *Hypoderma lineatum*, cause losses of about £27 million a year in Europe and £34 million in America, according to a recent OEEC report. Animals that are warble-infested suffer severe discomfort and do not make weight as readily as beasts that are free of them, but the main damage is to the hide. This takes the form either of blind warbles or old scars, or open warbles, *i.e.* punctures in the skin; the greatest number of such holes ever found in a single skin was 402 – and this was only from a year-old animal. Such holes make hides useless for upholstery, limits their use and consequently reduces their value.

The introduction by *Dow Agrochemicals Ltd.* of a new systemic drug, 'Etrolene', which destroys the larvae of the fly while small, and before they can puncture the hide or cause meat losses, is therefore of considerable importance to farming and to the meat and leather industries of the world.

Liquid Seed Dressings

A major development of special interest to corn and seed merchants in the U.K. is the recent introduction of liquid seed dressings by *Shell Chemical Co.* These are of two types: one, 'Panogen', is a mercury-based fungicidal dressing, which has been used for many years in Sweden, other European countries and America; the second, 'Astex', developed by Shell, is a new insecticidal dressing giving control of wireworm and other soil pests. A new seed-dressing machine is available in which 'Panogen' may be used alone, or both may be used in combination.

The advantages claimed for these liquid dressings over powders are that they eliminate the danger of harmful mercury-laden dust being in the atmosphere or contaminating the mill and that they can be applied to seed with complete uniformity, without risk of subsequent loss from the seed, prior to drilling.

Overcoming Resistance

The new 'Crag Sevin' insecticide, a relatively safe product, manufactured by *Union Carbide International Co.*, is for use on apples and peaches for the control of codling moth, apple maggot, leaf rollers, apple aphids, plum curculio, Oriental fruit moth, periodical cicada, and the peach twig borer.

The insecticide, a carbamate, is quite different from the chlorinated hydrocarbon, phosphate and other chemical insecticides now in general use. As a result it will control insects which have grown resistant to these other insecticides.

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World Crop Reports

INTERNATIONAL REPORTS

Crop Acreages

Increases in cultivated acreage have played a relatively small part in the marked expansion in world agricultural production since 1935–39.

From 1935–39 to 1956 the total world acreage in the major field crops increased only by 11.6%, or about 0.5% a year. The largest acreage planted to cultivated crops was in 1956, totalling 1,607 million acres, compared with the average of 1,440 million acres for 1935–39 and 1,500 million acres in the period 1950–54. Since these crops include all those requiring large acreage, except the millets, grain sorghums and associated crops, these changes in acreages are fairly indicative of the changes in the total world acreage devoted to crop production.

Most of the increases in cultivated acreage have been small. Crop acreage in Asia in 1956, where the greatest efforts are being made to expand agricultural production, was about 75 million acres, or 13% above the 1950–54 average, but has increased no further in the last two years. In other areas a decline of about 20 million acres in North America since 1950–54, primarily because of the U.S. Soil Bank programme, has been offset by increases of about 6 million acres in South America, 3 million in Europe, 3 million in Oceania and 7 million in Africa.

More acreage was planted to *wheat* than to any other crop and the increase in total wheat acreage has amounted to nearly 19%, due to the marked expansion in the U.S.S.R. and China, and to the shift from rye to wheat. In 1958 *rye* acreage was only 77% as large as in 1935–39 because of the change-over.

The acreage of *rice*, second only to that of wheat, has expanded even more rapidly than wheat. In 1958 the total acreage of 277 million acres was a new record and was 25% above the acreage in rice in 1935–39. *Soya beans*, *groundnuts* and *barley* are the only other major crops which have shown a marked expansion in acreage since 1935–39. The expansion in soya bean and groundnut acreage has been largely due to greater demand for vegetable oils, whereas the expansion in barley was largely a shift from oats in competing areas.

The acreages of most of the other major crops have remained relatively steady or declined since pre-war. The *maize* acreage has expanded moderately, but the total acreage in major feed grains in 1958 was practically unchanged since 1935-39. The world's *cotton* acreage has also continued to be relatively constant, fluctuating around 80 million acres a year. The acreage under flax, about 20 million annually, has also shown no significant trend.

Several crops have shown definite upward trends in yield since 1939. The most pronounced and persistent increases have been in the yield of maize and cotton, which in 1958 were 40% and 36% respectively above the 1935–39 average. Yields of oats, barley, potatoes and tobacco have also shown significant though less pronounced upward trends since 1939. Yields of wheat have increased moderately, despite the expansion into new areas of uncertain production. Rice yields have also shown an upward trend from the low levels reached in 1950–54, but 1958 is the only recent year exceeding the 1935–39 average.

Estimated world acreage for selected field crops

(Million acres)

Crop	*Average* 1935–39	*Average* 1950–54	1958
Wheat ..	425.1	447.3	504.4
Rye ..	101.3	90.2	78.7
Rice (rough)	222.1	256.1	277.4
Maize ..	222.6	222.4	236.6
Oats ..	144.0	128.7	113.7
Barley ..	117.4	121.1	136.0
Sugar (beet)	8.3	11.1	14.9
Beans (dry edible) ..	10.3	13.4	14.8
Potatoes ..	29.2	26.5	25.8
Soya beans	29.0	45.2	51.7
Groundnuts	22.3	30.1	38.8
Flaxseed ..	19.7	17.4	20.1
Cotton ..	81.1	81.9	79.4
Tobacco ..	7.6	8.7	9.4
Total of above crops	1,440.0	1,500.1	1,601.7

World Citrus Crop

The 1958–59 world citrus crop was generally larger for all types of fruit in all areas.

Oranges: Mediterranean production for this crop year reached a record owing to new plantings. *Israel's* gain in production is from new orchards. *Algeria's* crop continues to be limited by disturbances which hinder normal farm operations.

Production in South America continues to increase as new plantings in *Brazil* come into production. *Argentine* production also continues to rise, but much of this crop is unharvested, low-grade fruit.

In *South Africa* poor growing conditions, drought and 'black spot' disease have again reduced the orange crop, but much larger production from new plantings is possible.

Good crops in California and recovery from frost damage in Florida have resulted in a *U.S.* orange crop over 21 million boxes larger than that in the previous season.

New plantings in the Mediterranean, South America, South Africa and U.S.A. indicate much larger crops in the future.

Grapefruit: World grapefruit production was up because of a larger crop in Florida, where groves recuperated from frost damage of the previous season. Production also increased in *Trinidad* and *Israel* as a result of new plantings.

Future grapefruit crops should be much larger in the U.S.A. when extensive plantings of pigmented grapefruit in Texas come into production. In Israel new plantings are also likely to increase production.

Lemons: Larger Mediterranean crops have led to increased world production. *Italy's* large crop of winter lemons reduced prices of Italian fresh fruit, juice and lemon oil. Argentina grows more lemons than any other *South American* country, but much of its crop is unharvested.

REGIONAL REPORTS

Canada

Total grain acreage in Canada this year is about 1.3 million acres larger than in 1958; increases in wheat and

oats were partly offset by a substantial reduction in barley acreage.

Wheat acreage is estimated at 23,065,000 acres, 10% above the 1958 figure. The increase is in the spring wheat area, which, at 22,640,000 acres, is 11% larger than in 1958, but it is still 6% below the 1948–57 average. Winter wheat acreage, in contrast, is 27% below last year's area, reflecting a heavy winter kill. *Durum* acreage is down for the second successive year and the preliminary estimate of 1,018,400 acres is 9% less than in 1958.

Acreage in *oats* is estimated at 11,391,300 acres, moderately above 1958. *Barley*, however, dropped from 9,548,000 acres in 1958 to 8,288,600 this year. Total *rye* acreage is estimated at 516,600 acres, very slightly below 1958, but 46% below the 1948–57 average. Acreage in summer fallow is about 24 million acres, a little below last year, but well above average.

Mexico

The 1959–60 *cotton* crop in Mexico is now estimated at around 1,750,000 bales (500 lb. gross). This is a decline of 25% from the record crop of 2,345,000 bales last season, and 15% below average production of 2,050,000 bales in the past five seasons (1954–58).

This is the result of an even sharper reduction in acreage. The plantings in 1959–60 are estimated at 1,717,000 acres, a further reduction of 32%. The principal cause of this decline was the tightening of production credit that accompanied the decline in Mexican cotton prices since late in 1958.

Peru

Total *cotton* production in Peru for 1958–59 is estimated at 510,000 bales, compared with the 1957–58 crop of 508,000. Tanguis production was probably around 5% below the 1957–58 crop of 401,000 bales, because of insect damage and water shortages in some areas.

The reduction in the Tanguis crop was offset by an increase in production of extra-long staple Pima and Karnak, which reached a record level of 128,000 bales, compared with 107,000 in 1956–57. This 20% increase was attributed to larger plantings of this type and more effective control of pests.

The total area planted to cotton in 1958–59 was 556,000 acres, compared with 593,000 last season.

The 1959–60 crop of Pima and Karnak, planted during January–March, is expected to be considerably below the 1958–59 crop. In some Pima- and Karnak-producing areas as much as 25% of the cotton land has been shifted to rice production, and in other areas cotton land is being used for pasture.

Greece

The 1959 *wheat* acreage in Greece is the largest on record, according to the latest official estimates. The condition of the growing crop was very satisfactory at the end of April, and if weather conditions are normal, yields should be about the same as the record yields of 1958.

Production, therefore, is forecast at about 66 million bushels, which is nominally above the record out-turn last year. The large harvest of a year ago provided a surplus over domestic needs, and Greece is now, for the first time, a net exporter.

Europe

Denmark, northern West Germany and the Netherlands were the areas hardest hit by the drought in north-western Europe from about mid-May to mid-July; France, the U.K., Belgium and Sweden also were affected. *Hay*, *pastures* and *spring grains* (mainly barley and oats) showed the most deterioration; *deciduous fruits* and *root crops* were damaged in some areas.

However, while the outlook for *wheat* crops in some countries is not as favourable as it was last spring, a good wheat crop is expected in most countries, and in Western Europe as a whole. The areas hit hardest by the drought are normally large feed importers. The decline in their output of coarse grains and hay, and poorer pastures, will therefore necessitate larger imports of feed grains and protein feeds in 1959–60.

England and Wales

The weather during August was warm, sunny and very dry apart from thunderstorms, which were heavy in some south-western areas, and outbreaks of thundery rain.

Considerable progress was made with the harvesting of all *cereal and pulse crops*. The quality and condition of harvested *wheat* was reported to be very satisfactory, although some spring-sown crops were light. The yield of wheat was forecast at 28.2 cwt. per acre, as compared with a five-year average (1954–58) of 24.8 cwt. and a yield of 24.5 cwt. in 1958. The condition of the harvested *barley* was on the whole good, but the quality was variable; yield per acre was expected to be 25.2 cwt., as compared with a five-year average of 23.1 cwt. and a yield of 22.8 cwt. in 1958.

It was reported from some areas that the quality of *oats* harvested was variable, but on the whole the condition of the grain was good. The yield per acre was forecast at 21.9 cwt., as compared with a five-year average of 19.9 cwt. and a yield of 19.8 cwt. in 1958. *Mixed corn* was expected to yield 21.8 cwt. per acre, as compared with a five-year average of 19.8 cwt. and a yield of 19.6 cwt. in 1958. The quality and condition of *rye* were good and yield was forecast at 19.6 cwt. per acre, as compared with a five-year average of 19.4 cwt. and a yield of 19.4 cwt. in 1958.

The *potato* crop was variable. Showers increased bulk, but second growth was reported from many areas; the incidence of blight was slight except in some south-western districts, where it was widespread. The yield of second early and maincrop varieties was expected to be 8.2 tons per acre, as compared with a five-year average of 8 tons and a yield of 7.1 tons in 1958.

On the whole, *sugar-beet* crops made satisfactory growth. Virus yellows were spreading slowly in many districts. *Mangolds* were variable and the yield per acre was expected to be below average. *Turnips* and *swedes* were backward and crops were patchy in many areas. Aphis attacks were reported in several districts and many crops were affected by mildew. The yield per acre was expected to be below average. Early-sown *kale* made good progress, but late-sown crops were backward. Weed infestation and aphis attacks were reported from several areas.

Acknowledgment is made to the *Association of Agriculture's Farming Facts*, to *For. Crops & Mark.* and to *Spec. Reg. Infor. Services* for much of the information contained in the above reports.